AUTOMATION

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SEPTEMBER 1955
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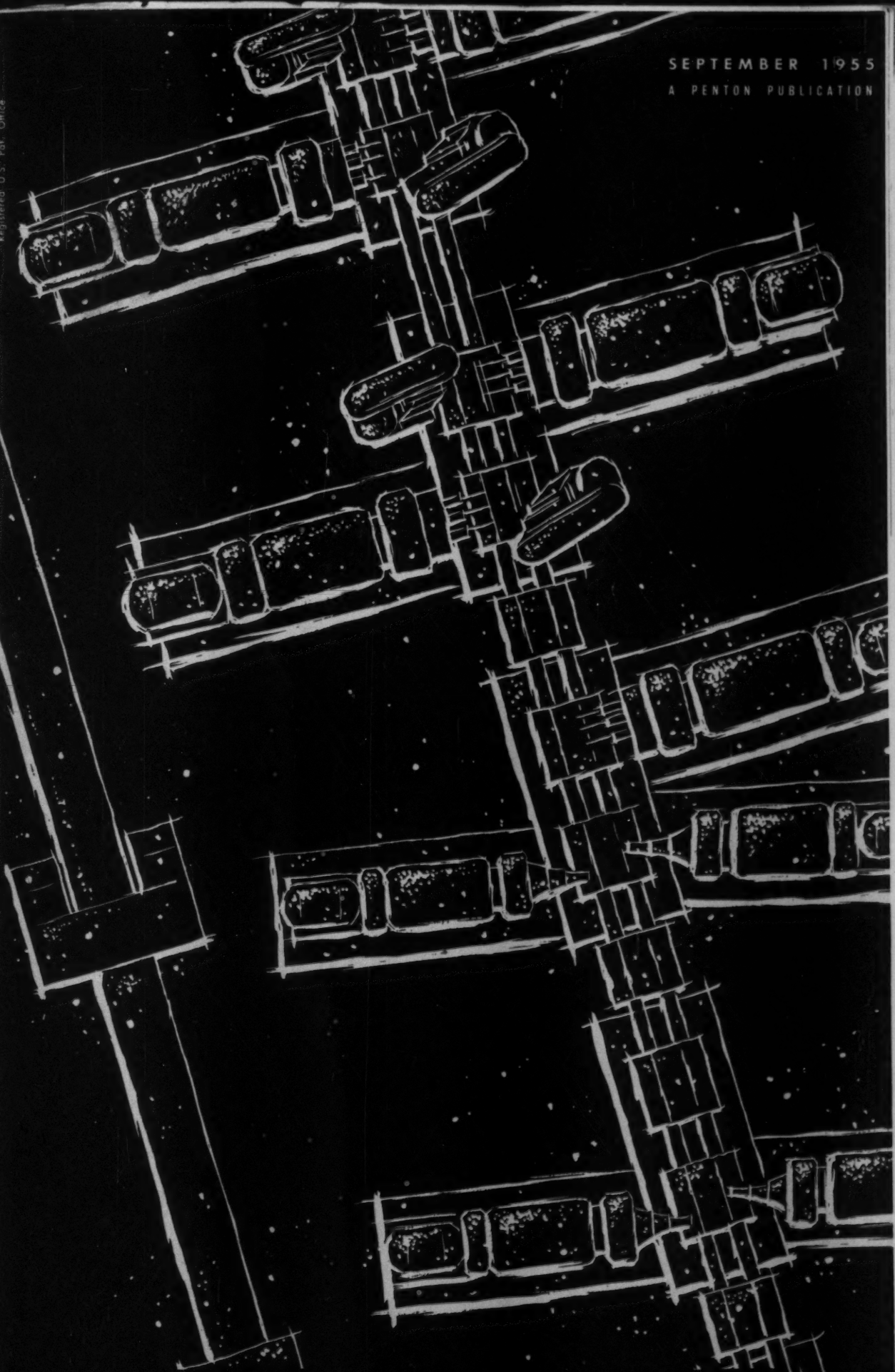


THE MAGAZINE OF AUTOMATIC OPERATIONS

WEAN "AUTOMATED" TRANS-CAR LINE SOLVES HEAVY PARTS HANDLING PROBLEM

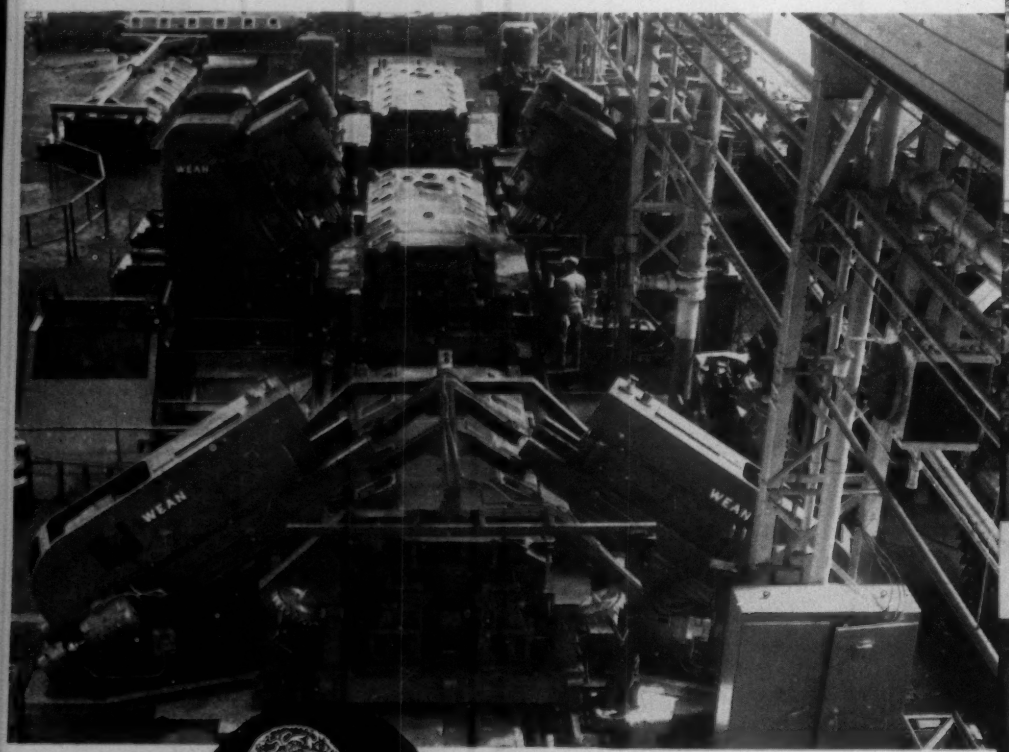
Unique system carries bulky sections through entire machining operation

The Massey-Harris Co. is used to handling and precision working large machine components. Thus, when they accepted the contract to produce combat vehicle hulls for the Army they immediately got in touch with Wean Equipment engineers.

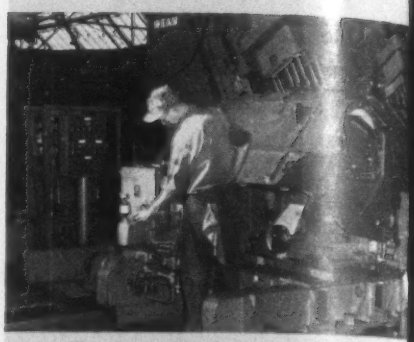
A team of Wean Equipment engineers working with a similar group from Massey-Harris soon vetoed the possibility of using standard machine tools on a cost basis. It was decided a complete line, especially built to do the job, was the only practical answer.

In eight months' time, Wean Equipment developed and built the now famous trans-car line. The line is composed of three stations: milling, drilling, and boring. The unusual feature is the car that operates on a set of tracks, running between stations, and eliminates all handling of the bulky, heavy hull.

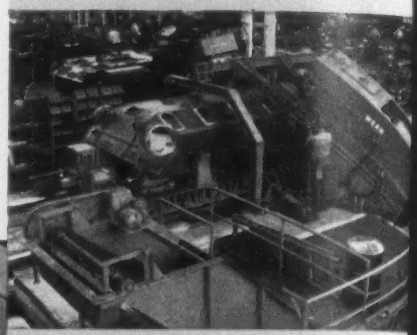
If special "automated" machinery is what you're looking for, call in a Wean Equipment man today. He represents probably the widest experience in specialized machinery to be found anywhere. Like Massey-Harris, you'll find Wean the surest, most inexpensive way to soundly engineered, result-getting machinery.



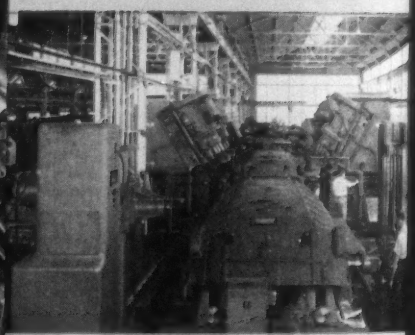
Over-all view of Wean Line that effected tremendous savings in producing giant hulls.



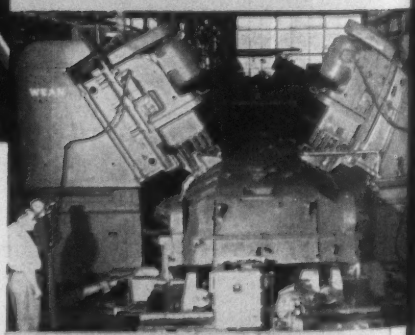
Unique trans-car that carries hull from station to station.



Milling operation. Dry cutting with carbide cutters. Air jets remove chips.



Drilling operation. Beneath the floor a coolant system with magnetic chip separator.



Boring operation. Drills, taps a reamers are of high speed steel. operations are automatic.

Wean

EQUIPMENT CORPORATION
CLEVELAND, OHIO

SEPTEMBER, 1955
Vol. 2—No. 9

AUTOMATION

THE MAGAZINE OF AUTOMATIC OPERATIONS

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automation outlook

AT THE GATEWAY

". . . we stand today at the gateway of what promises to be a great scientific revolution which will probably work a far greater change in our mode of living than the so-called industrial revolution has wrought in the past century or so. Most of us cannot even imagine the wonderful new devices and appliances that will become commonplace necessities of our daily life in the next few decades . . . And all of this . . . experience has shown . . .will mean more jobs, more purchasing power, more leisure and a more comfortable life for our people . . ."—*Benjamin F. Fairless, chairman of the board, United States Steel Corporation.*

AREA IS SECONDARY

". . . automation relies, of course, on continuous and expanding research and development activities in order to become a reality. The development of new products, processes, systems, and mechanisms relies heavily on the engineer's training, skill and ingenuity. From his point of view most problems are merely local. That is, he must solve the singular problems of his department, plant, or product. But the area in which the problem arises is often secondary. The textile and food industries and the insurance office are equally fair game for his efforts. It is satisfying and surprising to see how rapidly new areas are being tackled and subdued. The automatic factory and the automatic office will thrive because we demand higher production at lower cost, less human effort, and greater leisure and adaptability to the shifting demands of a better educated market. . ."—*David Rubentien, senior scientist, Armour Research Foundation.*

NURTURES EXPANSION

". . . the chemical industry generally have been leaders in the movement toward advanced instrumentation and automatic controls. If this kind of development actually meant fewer jobs, then employment in the chemical field would have plunged. At least, it would have declined at a rate exceeding that of industries in which the so-called automation was less evident, such as the printing trades or some of the building crafts. The plain fact is that employment in the chemical industry has increased more dramatically than has been the case in any other field. The reason, of course, is that new methods of automatic control have, in themselves, been responsible for much of the expansion. It is obviously beside the point to argue whether or not automatic controls have displaced this number or that number of people in the manufacture of nylon. Without "automation" it would be impossible, literally, to produce nylon at all. Therefore, the thousands of people making nylon represent a net gain in employment, for, if it were not for this new type of operation, their jobs would never have existed. . ."—*Du Pont Stockholder.*

NO DISAPPROVAL

". . . the CIO can view this big new technology without panic because it is a strong labor movement. In past times when workers tried to destroy machinery for fear the machinery would destroy their jobs, the action came because there was no labor movement or a weak and ineffective one. Because we now have a labor movement which can have some voice in the decisions that are made about these matters, we don't need to get panicky or hysterical. We can sit down and work out these things together with other elements in the society. We do not look with disapproval upon the new technology, but we say—because its impact is going to be considerable—we intend to go down the road and meet this new thing, take it by the hand, and help it in the direction that will be useful for all of society. . ."—*Ted F. Silvey, National CIO.*

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BPA

AUTOMATION news

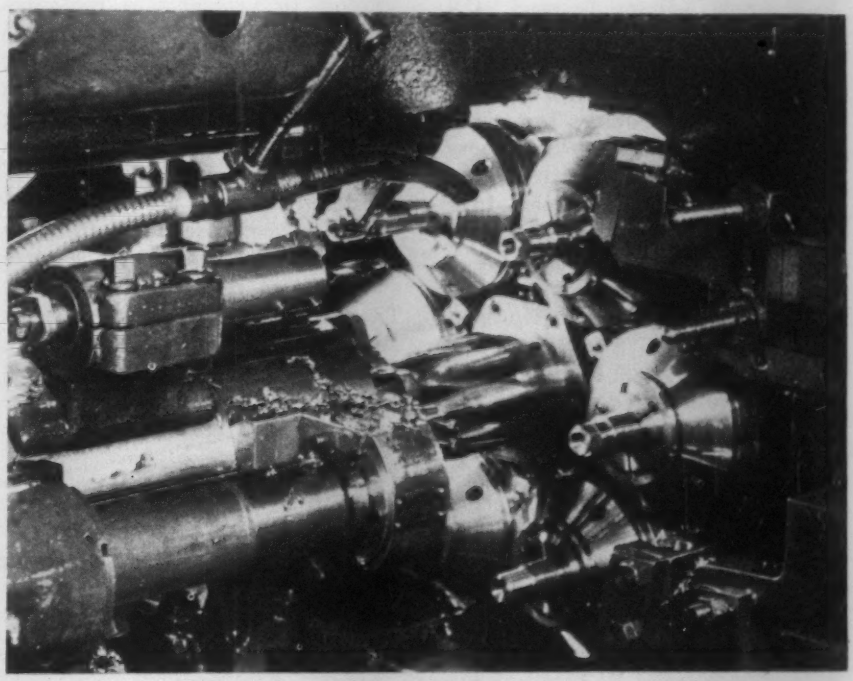
Today's events and developments in the field of automation

Polygon Shapes Turned With Unique Accessory

DEVELOPMENTS which upgrade and broaden the scope of operations of existing equipment make a very definite contribution to the advancement of automation. Typifying the application of unique accessories to existing machine tools to achieve a higher production rate is the Chatwin Polygon Tool Box, distributed in the United States by Bradley Machinery Sales Co., Inc.

The box was developed for the purpose of turning hexagonal, octagonal, square or any irregular shapes within its capacity—quickly and free from burrs—thereby eliminating the necessity of transferring certain types of work from a lathe to a milling machine. Further developments permit use of the polygon tool box on most types of turret and automatic lathes for production of internal and external taper and boring of polygon shaped holes to afford perfect mating to external shapes produced on the same box.

Briefly, the box comprises a holder for a tool which can slide transversely under the control of a rotary cam that is journalled in the body of the box. On turret lathes the cam is driven by the lathe spindle; on multi-spindle automatics the cam is driven from the rear by means of a coupling or shaft connected to the rear gear box. The cam corresponds with the square, hexagonal or other shape to be turned on the work. In use the work piece is turned in the ordinary way to the size across the corners and then the polygon turning box is fed along it. The rotation of the cam causes the tool-holder with its cutter to reciprocate, thereby generating the desired shape on the turning workpiece.



SHOWN in operation on a Cone automatic, a polygon tool box is turning hexagonal shape on round stock. Cam actuated cutting tool in box is driven from rear gear box. Various shapes turned with Chatwin Polygon Tool Box are free from burrs, and require no subsequent milling operation.

Tape Programmed Press

COMPLICATED hole patterns, including openings of many sizes and shapes are located and punched in large steel sheets with new, completely automatic turret punch presses manufactured by the Wiedemann Machine Co. The press will be introduced at the Machine Tool Show in Chicago's International Amphitheatre. The press and work locating table are controlled by a tape fed programming unit to perform all functions automatically—simultaneously positioning work under punch, selecting turret station carrying proper punch and die (any one of 20) and, then, tripping the press. This type of cycle is repeated until all holes have been punched.

RCA Buys Admiral Automatic Production Line

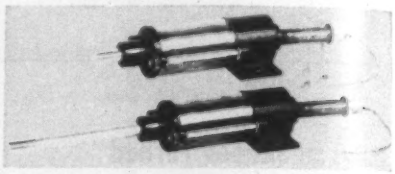
FIRST section of an automation line for production of television receivers has been shipped by Admiral Corporation to the Radio

Corporation of America, it has been announced by **John B. Huarisa,** executive vice president of Admiral.

The electrically controlled automatic equipment, designed and built by Admiral engineers, is similar to the automation line used in the production of its television receivers since July 1954 (see AUTOMATION, Feb. 1955). According to Huarisa, Admiral licensed RCA in January 1955 under patents pertaining to radio, television and automation. The machines shipped to RCA insert resistors in printed circuit boards. Additional machines scheduled for early shipment will insert wire jumpers, tube sockets and other components. Admiral's 1956 TV line features a chassis in which three printed circuit sections are used, comprising approximately 80 per cent of the wiring. Nearly 200 different components are inserted automatically in Admiral's production line.

Industrial Electronics Consulting Service

ESTABLISHMENT of a systems engineering group to assist industry in the application of electronic techniques to automatic production and quality control methods was announced by **Dr. P. S. Christaldi,** manager of the Instrument Div. of Allen B. Du Mont Laboratories Inc. This new Du Mont activity makes available to industry and other interested users a source of information and experience in the solution of problems of measurement and control in many diverse fields. The systems engineering group is equipped to investigate specific problems in manufacturing processes and to make recommendations for their solution either by designing new automatic electronically controlled equipment or by integrating electronic control systems into existing installations. The Du Mont engineering systems study group has been established, Dr. Christaldi stated, as the result of a growing number of requests from manufacturers and the government for assistance in applying the latest electronic developments in the design, manufacture, and operation of automatic machinery and processing and inspection equipment. This is particularly important in today's high speed machinery, operating too rapidly for control by human senses.



POWER cylinders that convert a small electrical signal to relatively great mechanical force are produced by Atlas Powder Co. The cylinders use a controlled explosive force to lift, and momentarily hold various weights through a varied range of distances. Possible uses—remotely controlled safety and locking devices, opening or closing electrical circuits and ejection of equipment from aircraft or guided missiles.

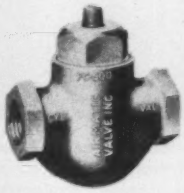
APPOINTMENTS of three divisional sales managers at Hartford Special Machinery Co. has been announced recently by **Robert A. Bode,** general sales manager. They are **L. K. Shepard,** sales manager of the Machine Tool Division; **Harvey L. Spaunburg, Jr.,** sales manager of the General Contract Division, and **Arnold T. Suhart,** sales manager of the Machine Tool Accessory Division. Shepard was formerly sales manager for the Drill Unit Div. of the Rockwell Mfg. Co., whose line of air-hydraulic drill units was recently acquired by and is now being produced by Hartford Special. He also has served as an engineer with Rockwell's Delta-Milwaukee Division. Spaunburg came to Hartford Special from an engineering job with the Underwood Corp., and Suhart from the Bardons and Oliver Corp.

RADIO program featured on station WTAG in Worcester, Mass., is designed to evaluate automation for its listeners. Entitled "Man Versus the Machine", the program contrasts the industrial scene in Europe and Worcester by a series of on-the-spot interviews. In an American interview, Archie K. Hughes, factory manager of Chain Belt Co., is shown with Louis Fontaine, producer of the program and F. W. McIntyre, Jr., vice president of Reed-Prentice Corp., and J. E. Dufresne, toolmaker at Chain Belt Co. Production of machinery and conveyor systems used in automation bring some 25 million dollars annually to over 7,000 Worcester workers.

Managers Discuss Automation

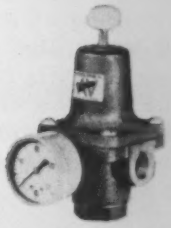
AUTOMATION and improved manufacturing methods were the main topics for discussion during a recent meeting of Bendix Aviation Corp. factory managers held at the

For DEPENDABLE AUTOMATION SPECIFY AIRMATIC

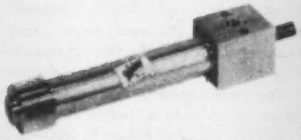


FLOW CONTROL VALVES

SEQUENCE VALVES



PRESSURE REGULATORS



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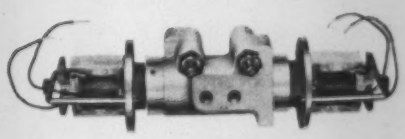

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The widespread use of AIRMATIC VALVES is convincing proof that they are outstanding and dependable and accepted by the most critical engineers.

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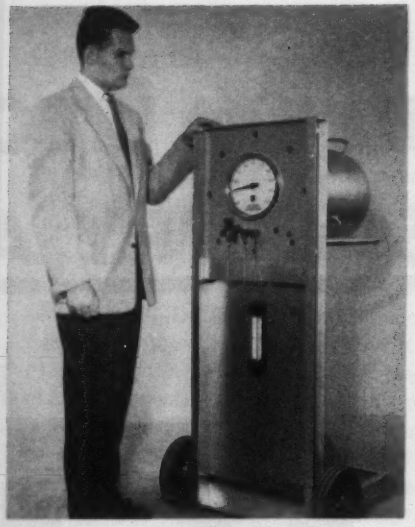
main plant of the Bendix Radio division. More than 45 managers and their first assistants, representing some 21 divisions of the corporation, were in attendance when the conference got under way.

Co-chairmen of the meeting were **George Faustman,** general factory manager at Bendix Radio and **Emil Wirth,** staff assistant at the Bendix Products Div. in South Bend, Ind. It was the first corporate meeting devoted exclusively to the exchange of manufacturing ideas between divisions.

ENGINEERS and builders, Walter Kidde Constructors, Inc., has established a new subsidiary, Kidde Automation Systems, Inc., to design, engineer and build automated warehousing systems, it has been announced by **William Collins,** president of the parent company and the subsidiary. Other officers of the new company include **Walter L. Kidde,** treasurer; **P. L. Griffith,** general manager and secretary; **George Schuck,** controller; and **David R. Angus,** sales manager. Formation of the new subsidiary is the latest step in the company's expanding activities in the automated warehousing field. Last April the company introduced its Kidde Warehousing System, which utilizes electronically controlled conveying equipment.

"The enthusiastic reception that warehousing men all over the country accorded our warehousing system, convinced us of the need for a company specializing in automation system," Mr. Collins said. "Actually, our industrial engineering department has been doing much pioneering in the field. Through Kidde Automation Systems, Inc., we shall be able to broaden and expand the scope of these activities."



PROCESS refractometer, one of four plant-type analytical instruments acquired by Consolidated Engineering Corp. from Phillips Petroleum Co., is designed to monitor continuously the refractive index of liquid process streams. Among its uses have been automatic control of liquid-stream blending and fractionating tower operation. The refractometer measures the difference in refractive index between a sealed-in liquid standard and a flowing sample drawn directly from a process line. This measurement is based on the bending effect caused by passing a ray of light from one medium to another of different refractive index.

Decennial Review of Attainments

ON THE OCCASION of the tenth year of operation of the Material Handling Institute, Inc., its president, **Robert H. Davies,** has reviewed the accomplishments of the institute during this past decade. Among the educational accomplishments of general interest in view of increased usage of material handling equipment are:

The institute organized users into chapters in industrial centers. These chapters, at the suggestion and with the assistance of MHI, formed the basis for the American Material Handling Society.

A traveling clinic composed of executives of MHI member companies has been organized to present panel type programs on various material handling subjects. These clinics provide users with an opportunity to present problems for which practical solutions are developed.

The educational committee of the institute publishes a series of booklets in a growing library of various technical phases of material handling.

The institute has sponsored a College-Industry Committee on Material Handling education to serve as a focal point for course outlines, teaching material and the source and authority on sound information concerning material handling education in over 125 colleges.

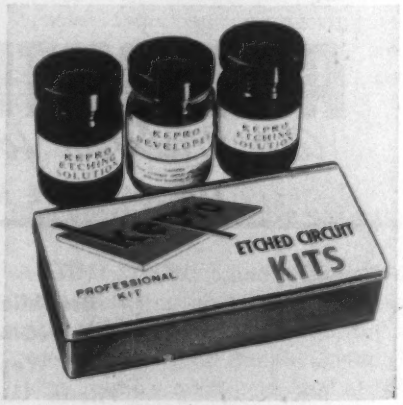
Traffic Control for the Future

IMPROVED highway service and maximum safety are result of closer control of traffic provided by electronic equipment. Demonstrated by New Hampshire Dept. of Public Works and Highways, control devices included television cameras and monitors supplied by

---

LABORATORY and prototype developments associated with automation projects are simplified by the use of the many experimental kits being placed on the market. Typical is a kit of an assortment of mechanical development apparatus, (left), which has been proved and selected by careful analysis in the laboratory of the manufacturer, Servomechanisms Inc. Parts can be used for any laboratory problem involving electromechanical development and control simulation.

All essential chemicals and materials for processing experimental etched copper circuits are contained in a kit offered by Keil Engineering Products. The kit utilizes a photographic process to produce commercial quality boards.



General Precision Laboratory and microwave link equipment provided by Raytheon Mfg. Co.

One man, from a central point, is able to check miles of a highway covered by strategically located television cameras and direct patrols to trouble spots. Cars' license numbers showed up clearly at the monitoring station. Also demonstrated were an automatic toll collector and radar operated warning signal which was activated by a speeding vehicle to signal for slower speeds.

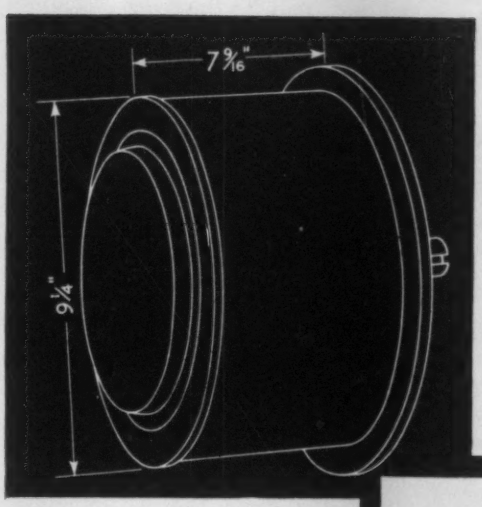
BOARD of Directors of Kraus Automatic Machines Corp., manufacturers of automation machinery, announces the election of **Walter J. Niles** as president, treasurer and

director of the parent company and its two wholly-owned subsidiaries. Prior to joining these automation concerns, Niles has been president of SoundScriber Corp. since 1950 and was previously president of Frederick Hart Co., now known as Daystrom Electric. As an executive of the North East Electric Co., Niles was closely associated with the development and marketing of the first electric typewriter.

Charles E. Kraus, who has acted as both administrative and engineering head of the concern which supplies automation equipment to many leading companies will devote his full attention to engineering and development.

Professionalism Spotlighted

NEW PRESIDENT of the National Society of Professional Engineers is **Allison C. Neff,** vice president of Armco Drainage & Metal Products Inc. Neff has served as vice president of the Ohio Highway



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& Turnpike Association, and is president of the Middletown City Planning Commission, and co-chairman of the Middletown Industrial Council. He is also a past president of both the Cleveland and Ohio Societies of Professional Engineers.

During the annual meeting, the consensus of advice given by leading engineering figures at a conference on a professional development was that engineers in industry are going to have to think and act like professional people if they are to live up to their responsibilities in an era of ever increasing technological complexity. From **Gerry E. Morse,** vice president, industrial relations, Minneapolis-Honeywell Regulator Co., the more than 300 conferees at the meeting heard that industry has found engineers to be "confused, frustrated, and dissatisfied." Morse advised that engineers who want the status and pay of professionals must act, work, and live like professionals. "The key to success is not only technical competence but also social and personal competence," he said.

The role of engineering education in engineer-industry co-operation was discussed by **N. W. Dougherty,** dean of engineering at the University of Tennessee, and president of the American Society for Engineering Education. Hitting out at the separation of management from the professional engineer, Dean Dougherty told the group that "it is time that the colleges taught their students the difference between a skilled workman and a professional. The colleges must join hands with industry in creating a good atmosphere for professionals to grow. Youngsters come to college filled with idealism and high aspirations for the future; good teachers help them develop these attitudes and ideals. It is certainly a letdown for them to enter industry and find that they are just other employees, that their names are on the payroll, and they seem lost in the multitude."

In another address, **Carl A. Frische,** vice president for operations, Sperry Gyroscope Co. pointed out that engineering management's responsibility includes making certain that engineers understand what is expected of them, reviewing progress at regular intervals, making the engineer feel that his work is worthwhile and is being recognized, creating a feeling on the part of the engineer that he is being treated fairly in comparison with other engineers, and helping to bring about public interchanges of general scientific and technical information. The idea of unionism for professional engineers has generated additional problems in engineer-management relations, the Sperry official said. "It is my belief that these union objectives, which occupy a prominent place in the traditional trade unionism that has developed among production, maintenance and craft employees, have no place among professional engineers and serve only to divert attention from the principal purpose of achieving constantly improving engineering goals," he said.

NEW name of Olympic Development Co. is to be Barnes Engineering Co. Activities of the company fall into three main categories. It is engaged in the development and production of infrared components and instrumentation for remote temperature measurement and control. Through Multra Co., a wholly-owned subsidiary, the company manufactures automatic assembly machines, recording refractometers and a control device. Binotrol, which automatically positions and controls the operation of machine tools and the industrial equipment. The company also owns Clarksburg Television Cable Corp. which operates a community antenna system. President of Barnes Engineering Co. is **Dr. R. Bowling Barnes,** who has received

wide recognition for his development and application of physical instruments and methods to the chemical industry. He holds some 40 patents and has published over 80 technical papers. Barnes received his doctorate degree in physics at Johns Hopkins University; served as director of physics division of the Stamford Research Laboratories of the American Cy-

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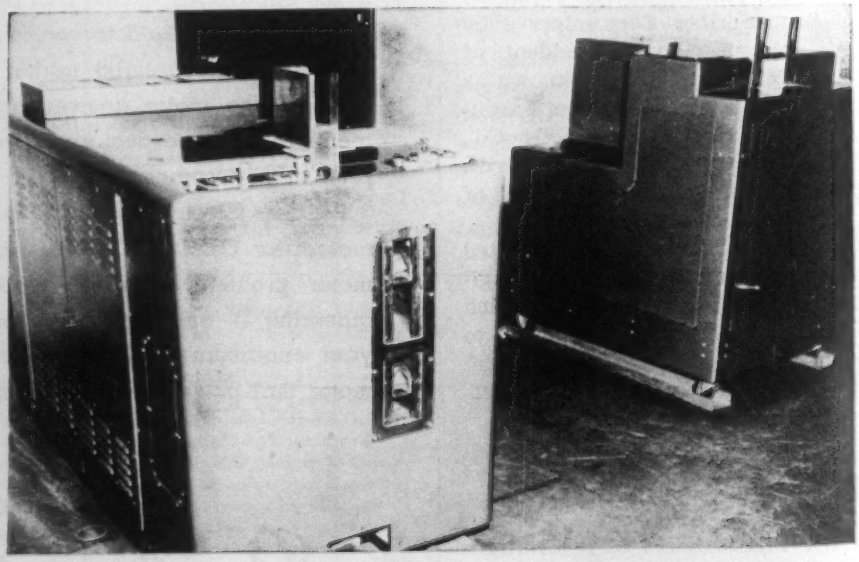
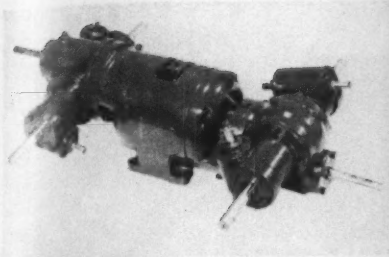


NEW electronic character recognition equipment produced by Burroughs Corp., reads the printed numbers on travelers checks at the rate of 7,200 an hour and transfers the information to punch cards. On the left is the reader device and on the right is the card punching unit. The reading device scans the printed numbers on each check (which identify its denomination and serial number) by means of special photo-electric process.



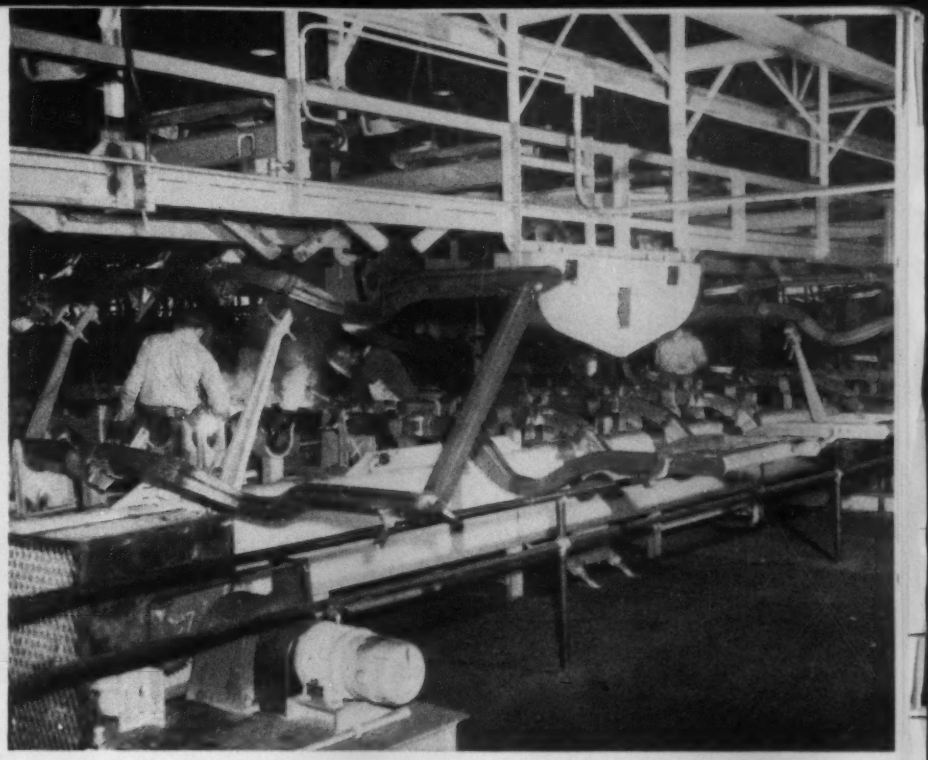
BUILT specifically for the Production Engineering Show to emphasize the possibilities of multiple shaft gearmotor applications, an operating fractional horsepower unit with 14 shafts running at selected speeds will be shown by the Master Electric Co. Extending from both ends of the gearmotor and from many angles, these types of shafts provide a variety of speed and power sources for machine tool drives where special designs can be justified by repetitive use of similar units.

anamid Co.; and was vice president in charge of research and development of American Optical Co.

Other officials of the Barnes Engineering Co. are **Dr. Charles J. Burton,** vice president and treasurer; **Eric M. Wormser,** chief engineer of the Infrared Div.; **D. M. Frothingham,** chief engineer of the Binotrol Div.; **Frank K. Lake,** chief engineer of Multra Corp. and **W. R. Tucker,** president of Clarksburg Television Cable Corp.

Tuning Control Stabilizes Reception

AUTOMATIC tuning of frequency-shift code receivers can now be provided by a tuning control unit produced by C.G.S. Laboratories. This tuning lock keeps the receiver tuned accurately to an incoming frequency shift signal at all times. This is true even though the incoming signal may drift in frequency or the receiver tuning change as a result of temperature variations or changes in the characteristics of the frequency-controlling components of the receiver. The instrument is applicable to either variable-tuned or crystal-controlled receivers. The tuning lock includes a control chassis and a separate electrically-controlled capacitor connected to the tuning circuit of the receiver. When attached to an inherently unstable receiver the lock



New Handling System

increases production while eliminating two lines

In one of the automotive industry's newest plants, production of frames for 1955 models was lagging, even though 6 lines were being used. Then Planet engineers were consulted.

They designed and installed a new frame handling system which exceeds current production requirements, doubling the output of the old-style line. *Now only 4 lines are used.* In addition, quality has been improved.

Here's how the system operates. The component parts of the frame are delivered by trolley conveyor to a frame assembly conveyor where they are automatically positioned for tack welding. The assembled frame is then discharged on to the frame welding conveyor illustrated above.

Here the frames are automatically rotated, 90° at a time so that all finished welding is done on a horizontal plane as the frames move by each welding station. Frames are then automatically conveyed through checking, cleaning, and painting operations.

If you have a production problem, why not consult Planet Corporation engineers? Write or phone today. There is no obligation.

PLANET CORPORATION

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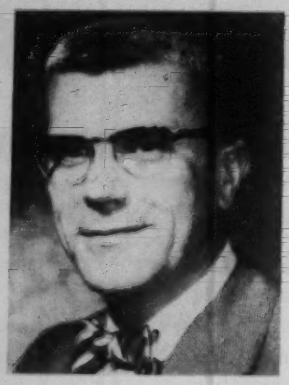
LANSING, MICHIGAN

- CONVEYORS
- ENGINEERED SYSTEMS
- FOUNDRY EQUIPMEN
- AUTOMATION
- STEEL FABRICATION

"IT PAYS TO PLAN WITH PLANET"

permits operating convenience equivalent to a highly stabilized crystal-controlled receiver. The chassis is designed for panel mounting on a standard 19-inch rack using 3½-inches of vertical space.

NEW DIRECTOR of engineering in the Communications and Electronics Div. of Motorola Inc. has been announced by **Daniel E. Noble**, division vice president. **Roy H. Olson**, electrical engineer with 20



years experience in radio, will direct the technical activity of the division's industrial products department. Olson has been associated with Motorola since 1951 during which time he has served as co-ordinator of the National Bureau of Standards missile fuse projects and as project leader for special military development tasks. More recently his work has been with subminiature missile electronic fuses. Before joining Motorola he was associated with Collins Radio Co. and at one time operated his own manufacturing and consulting firm. Among his accomplishments Olson counts the design and manufacture of mobile portable communication and broadcast transmitters, test instruments, fixed station broadcast transmitters, amateur receivers and commercial point to point high frequency transmitters.

LOG feeding device for the pulp and paper industry which unscrambles logs as they are picked up from storage piles and feeds them onto the belt conveyor gently and in orderly fashion has been developed by Hewitt-Robins, Inc. The machine resembles in appearance a huge soup bowl with a spout or chute. The logs are dropped into the big bowl from a grab bucket and then are whirled around until centrifugal force causes them to unscramble and escape in an orderly manner through the chute onto a conveyor. Since the logs are headed in the same direction as the travel of the belt when they come out of the machine, log jams and excessive belt wear are eliminated

MEETINGS AND EVENTS

Sept. 20-22—

Society of Industrial Packaging and Materials Handling Engineers. Tenth anniversary meeting and exposition to be held Kingsbridge Armory, New York. Additional information may be obtained from society headquarters, 111 West Jackson Blvd., Chicago 4, Ill.

Sept. 26-27—

Radio - Electronics - Television Manufacturers Association. Symposium on automation to be held University of Pennsylvania, Philadelphia. Additional information may be obtained from association headquarters, 500 Fifth Ave., New York 36, N. Y.

Sept. 26-30—

Atomic Industrial Forum. Trade fair of the atomic industry to be held Sheraton-Park Hotel, Washington, D. C. Additional information may be obtained from Forum headquarters, 260 Madison Ave., New York 16, N. Y.

Sept. 28-30—

Technical Association of the Pulp and Paper Industry. Testing conference to be held Sheraton-Kimball Hotel, Springfield, Mass. Additional information may be obtained from Wm. Schoenberg, exhibition chairman, 1878 East 18th St., Cleveland 14, Ohio.

Oct. 3-5—

National Electronics Conference. Eleventh annual conference to be held Hotel Sherman, Chicago. Additional information may be obtained from J. Kocik, c/o Illinois Bell Telephone Co., 208 W. Washington St., Rm. 300, Chicago 6, Ill.

Oct. 5-9—

World Plastics Fair and Trade Exposition. Featuring application of all types of plastics and production machinery. To be held National Guard Armory, Los Angeles. Additional information may be obtained from exposition headquarters, 700 Exposition Blvd., Los Angeles 7, Calif.

Oct. 10-12—

Systems and Procedures Association of America. Eighth annual international systems meeting to be held Sheraton Cadillac Hotel, Detroit. Additional information may be obtained from J. R. Daw-

son & Associates, 19 N. Washington, Ypsilanti, Mich.

Oct. 13-15—

Foundry Equipment Manufacturers Association. Thirty-seventh annual meeting to be held Greenbrier Hotel, White Sulphur Springs, W. Va. Additional information may be obtained from C. R. Heller, One Thomas Circle, Washington 5, D. C.

Oct. 23-29—

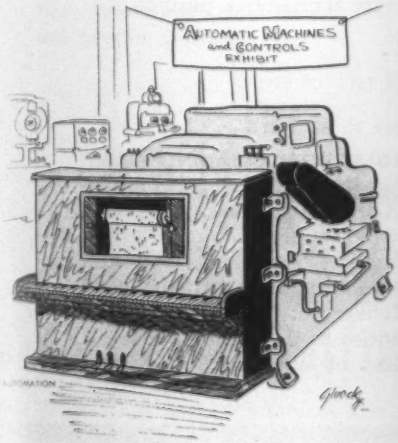
Instrument Society of America. Symposium of Philadelphia Section devoted to electronic and pneumatic automatic control loops. To be held Penn Sherwood Hotel, Philadelphia. Additional information may be obtained from R. F. Eisele, 4907 Stenton Ave., Philadelphia 44, Pa.

Nov. 7-9—

Eastern Joint Computer Conference and Exhibition. Sponsored by American Institute of Electrical Engineers, Institute of Radio Engineers, and Association for Computing Machinery. To be held Hotel Statler, Boston. Additional information may be obtained from Arrangements Committee, Box 223, Boston 1, Mass.

Nov. 14-18—

American Society of Mechanical Engineers. Exposition of power and mechanical engineering in conjunction with 75th anniversary meeting. To be held Chicago Coliseum, Chicago. Additional information may be obtained from International Exposition Co., 480 Lexington Ave., New York 17, N. Y.



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Vibration and Shock Resistant
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Cool-Running

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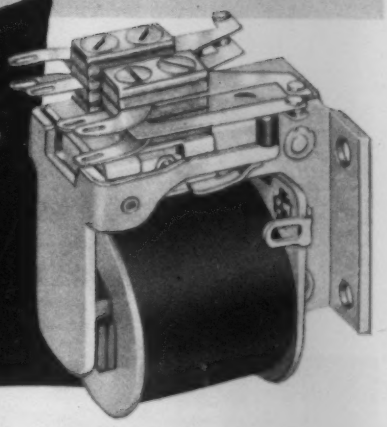

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Suitable for communications controls, microfilm and office machines, annunciator systems and others

Coils: Can be supplied for all standard voltages up to 220 volts, AC. Average coil consumption, 2.5 VA.

Contacts: 6PDT up to 5 amps. at average 7.5 VA; 4PDT up to 5 amps. at average 2.5 VA; DPDT up to 10 amps. at average 7.5 VA; fine silver. Other contact materials available.

Vibration: 10G at 5 to 55 cps.

Shock: 20G energized; 15G non-energized.

Size: 1½" x 1 1/16" x 2¼" depending on contact combinations.

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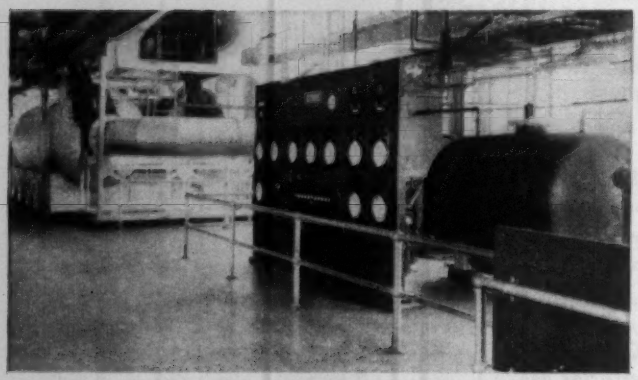
Bristol...automation... and you

Magic word, automation. Or push-button operation. It's a breath-taking concept, too – plants running practically unattended.

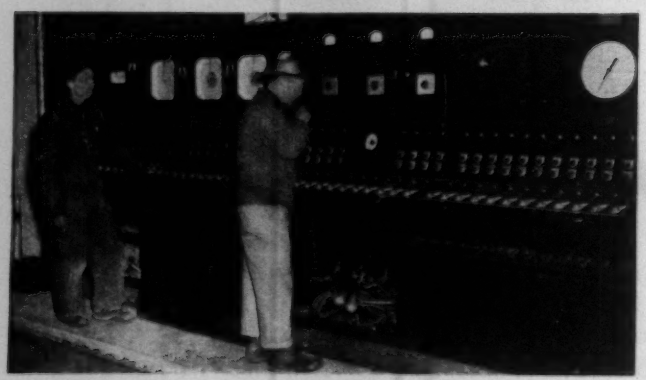
Breath-taking – but not *new*.



BRISTOL COORDINATED CONTROL SYSTEM automatically controls operation of "Columbia" Activated Carbon Solvent Recovery Plant at the New York Daily News. Similar control systems are used in many other solvent recovery plants designed and supplied by Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation.

BRISTOL'S "MECHANICAL BRAIN" is the leader of the Coordinated Process Control System . . . accurately coordinating all the variables, including mechanical operations, so that each phase of the process takes place in proper sequence.

AUTOMATION is often thought of in terms of plans or even dreams; here at the Buffalo Foam Rubber Products Plant of the Dunlop Tire and Rubber Corporation, it is a reality. This automatic plant, designed and built by Mechanical Handling Systems, Inc., Detroit, uses Bristol Dynamaster® Electronic Instruments and Automatic Controllers as part of a process employing today's most advanced automatic production techniques. The result – greater efficiency and productivity, lower costs, improved product, and stronger competitive position.



THE WORLD'S LARGEST COAL CLEANING PLANT employs automation in lubricating system. The Hanna Coal Co., Adena, Ohio, uses *Bristol Controls and Recorders* in its fully automatic time-controlled centralized system for mass lubrication. This system promotes safety and, above all, insures positive delivery of the right lubricant in the right quantities at the right time to all bearings, regardless of operating conditions.

Twenty-one years ago . . .

'Way back in 1934, The Bristol Company led the way in the field of automation by developing the Bristol Systems of Coordinated Process Control.

These systems automatically controlled and coordinated all of the variables and operations of a process—such as the time of operation of valves, pumps, blowers, dampers, and the control, at a definite value or according to a time program, of variables that affected the uniformity, quality, cost, and yield of a product – such as temperature, pressure, liquid level, flow, pH, humidity, and speed.

RESULTS: They eliminated variations in processing that caused inefficiency – cut down rejections and waste – insured product uniformity – helped cut processing time as much as from 10 days to less than 30 minutes. And these systems quickly paid for themselves.

A REVOLUTIONARY CONCEPT: They brought automatic plant operation to a startling reality and were hailed at the time as a fundamentally new development – which would in time revolutionize manufacturing.

Today, Bristol Coordinated Control Systems are used in the chemical, oil refining, rubber, tobacco, textile, steel, metal working, food, paper, the automotive industries, and many others. They are so completely automatic that it is only necessary to push a button to start up, another to shut down.

The modern solution to processing and manufacturing control problems

Bristol's System of Coordinated Process Control is made possible only by the following unique combination of facilities, which have been developed during 66 years of building and applying thousands of automatic control systems and instruments in practically all industries:

1. The complete line of modern Bristol Automatic, Controlling, Recording, Electronic, and Telemetering Instruments, representing some of the most advanced ideas in instrument engineering.
2. Bristol's Fully-Automatic Time-Cycle Controllers or "Mechanical Brains".
3. Bristol's ability to combine electronics and the mechanical phases of automation.
4. The ability and facilities of Bristol's engineering staff, gained by long experience and Bristol's pioneering work in the field of automation.

Bristol Application Engineering is at your service:

Our application and field engineers are ready to solve control problems involving automation and Coordinated Process Control Systems by working jointly with your research, development, and plant engineers.

Have you an automation problem?

Our application engineers and nation-wide group of field engineers would like an opportunity to work with your technical staff on any problems of automation for which Bristol Controlling and Recording Equipment and Bristol Coordinated Control Systems appear to be the solution. 5.3

BRISTOL PRODUCTS:

Automatic Controlling, Recording, and Telemetering Instruments for:

Pressure, Vacuum, Absolute Pressure, Draft, Differential Pressure, and Barometric Pressure.
Temperature (Thermometers, Potentiometers and Pyrometers).
Flow, Water and Liquid Level, and Specific Gravity.
pH and Conductivity.
Speed of Travel and Rotation.
Humidity.
Voltage, Current, Power, and Load Totalization.
Mechanical Motion, Position and Operations

Including:

Automatic Control Systems
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Time-Cycle Controllers
Time-Program Controllers
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POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

(Advertisement)

Report to Cylinder Users . . .

Here at Miller Fluid Power we have a pattern which we follow. A goal at which we are shooting. The pattern isn't too simple. And the goal isn't an easy one. But we've been making progress. Our position right up in the van of the industry proves that.

Our job is the production of cylinders. Basically, there's nothing anyone can do to alter a cylinder. It was old a hundred years ago. It probably won't change basically in another hundred years. But in the details of the cylinder, change is the major element.

Which is very much like industry itself. Basically industry has not changed since free enterprise was conceived on this continent. But in every detail it changes from year to year.

It's the Thousandths That Count

There was no single big thing wrong with the cylinders being manufactured yesterday. Just a lot of little things. So Miller Fluid Power made the improvement of little things its business.

We experimented with new materials and made safer, more dependable steel heads and caps. We hard-chrome-plated 110,000 PSI yield point steel to improve radically the piston rods. We raised the efficiency of operation to new peaks. Striving for quality in the smallest detail we improved in a dozen parts which are hidden from sight.

For instance, most cylinders leaked in operation. Miller made one that wouldn't leak. To prove it, we went away out on a limb and guaranteed leak-proof operation. And made the guarantee stand up.

We Learn by Listening to You

We saw our customers as thousands of men in thousands of shops wrestling with thousands of production problems. We made those problems ours and produced cylinders to whip those problems. Maybe we didn't revolutionize the cylinder business in the process. But we sure helped. We know that.

We learned to produce what we believed was the best cylinder on earth. We also learned that the best cylinder today wouldn't be good enough tomorrow. So, with the good one in production we listened some more, experimented, and came up with a better one.

Miller Fluid Power is a young company in an old field. We are young, progressive, and willing to listen. We innovate without being prodded.

Discussion is a Two Way Street

On occasion we like to have others listen to us. Especially when what we have to say will help our customers. That is the idea behind our College of Cylinder Knowledge. We know a lot about cylinders. Though not as much today as we will tomorrow or the day after.

In our College of Cylinder Knowledge we try to show you what good cylinders can do for you. And what you should demand in any cylinder you buy. We meet other men who know what they want in a cylinder. We listen to their wants and try to explain what perfection in detail means.

We believe that when the users of cylinders sit down across the table from the producer who is trying to make the best, better cylinders result.

We'll be carrying that belief into the Production Engineering Show at Navy Pier in Chicago on September 6. Our College of Cylinder Knowledge booth will be open for that kind of discussion. We'll listen and learn.

The only way we can learn is from you. We can help you. But not until you've dropped that problem of yours in our lap. Your problem contains the stuff of which the better cylinder will be made. The cylinder that will have that quality plus which we like to think is the stamp of Miller Fluid Power.

Remember this when you see the sign over Booth 1819-23. We'll be there to listen to your suggestions, demands and questions. Also, because we are in the cylinder business, we'll be there to show you a cylinder you will want to buy.

Frank Flick

President

MILLER FLUID POWER COMPANY

2015 N. Hawthorne Avenue

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Visit Miller

BOOTH #1819-1823

Production Engineering

NAVY PIER SHOW CHICAGO

By FLOYD G. LAWRENCE Detroit Editor

DETROIT DATELINE

IT PAYS TO AUTOMATE

EVER WONDER how automation is doing abroad? Although European mechanics have long been respected for their savvy, there are good reasons to presume that even in auto plants like those of West Germany automation would be hard to come by.

In the first place, production is low. Autos are a luxury purchased only by the few and frequently considered a lifetime purchase. The Mercedes 300 SL sports car shown in the photo rolls off the line at a doddering five units per day production rate compared with its 175 mph on the highway. Although Daimler-Benz produces many, many types of cars and trucks output totals only about 67,000 units annually.

Even the ubiquitous Volkeswagen achieves an output of only about 242,000 units per year in contrast to outputs of Ford and Chevrolet in excess of one million cars each.

For many, an even stronger point against automation is the low labor rate in West Germany. The average hourly wage rate last year was only 23.8 cents as against average auto worker wage rates in this country of about ten times that amount.

Yet, while low volume and low wages might mitigate against automation, many examples of automation can be found in the Daimler-Benz plants. At the Unterturkheim plant near Stuttgart there is a new transfer line being installed by Ludwigsburger Maschinbau which performs 18 milling, drilling, boring and facing operations to completely machine rear axle housings.

Other examples could be cited in sheet metal, engine part machining, etc., but the striking point stands out. Efficient tool utilization, space utilization and quality standards make automation pay even when the two most commonly cited criteria for automation, high wage rates and high production, are lacking.

▶ Industrial Tool

An advantage of transfer-type machines with automatic loading and unloading is that they take much less floor space than a collection of single-operation machines doing the same job. The parts they produce are of unprecedented accuracy and at amazingly low scrap levels. Less floor space, better products and less scrap. These are important cost and sales factors that mean much more to most plants in the final analysis than a program of getting more output per worker by having him feed the machine faster.

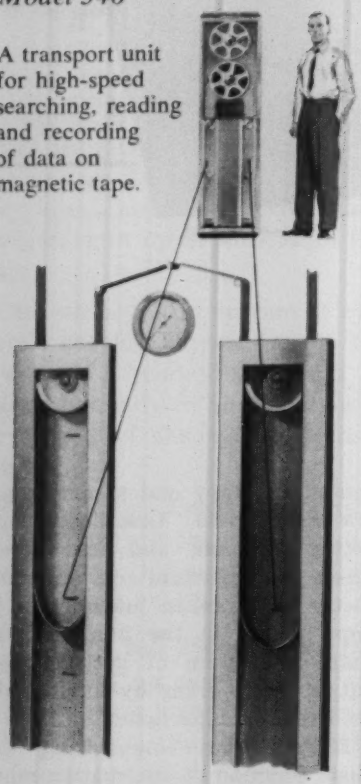
Rather than emphasizing this basic function of automation many management men seem resigned to defensively admitting that a specific individual or group of individuals may be laid off when automation comes into the plant. The union finds a relatively unobstructed field for its arguments that workers are displaced by automation. Even citing statistics which show that employment goes up with the rate of mechanization

Assembly of Mercedes 300 SL sports cars proceeds at rate of five units per day

DataReader

Model 546

A transport unit for high-speed searching, reading and recording of data on magnetic tape.



Vacuum column tape control

Vacuum method of sensing provides servo control of the reel drive motors, resulting in a highly sensitive tape feed control. Only a short length of tape need be accelerated to bring the tape to full speed. Exceptionally rapid acceleration and minimum tape strain are realized, since no mechanical system inertia need be overcome.

PERFORMANCE:

RAPID START—STOP—REVERSE—from stop to full speed in 6 milliseconds.

HIGH TAPE SPEED—optional single speed of 30, 40, 50, 60 or 75 in/sec.

TWO-DIRECTION SEARCH—either direction, automatically at full speed.

REMOTE OPERATION—forward, reverse, stop, rewind and selection of reading and writing.

END-OF-TAPE SENSING—stops automatically at either end of tape.

RAPID REWIND—2400 ft. of ½" or ¾" tape in 3 minutes.

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ElectroData Corporation maintains a nationwide sales and service organization.

seems generalized and meaningless in the face of specific workers losing specific jobs.

In that light it is not difficult to understand why many workers feel automation eliminates jobs rather than helping to create them. These workers in many cases do not realize that automation enables industry to give the worker annual raises based on the productivity factor which in the case of manually loaded and unloaded equipment would have to come from increased effort on the part of the worker himself.

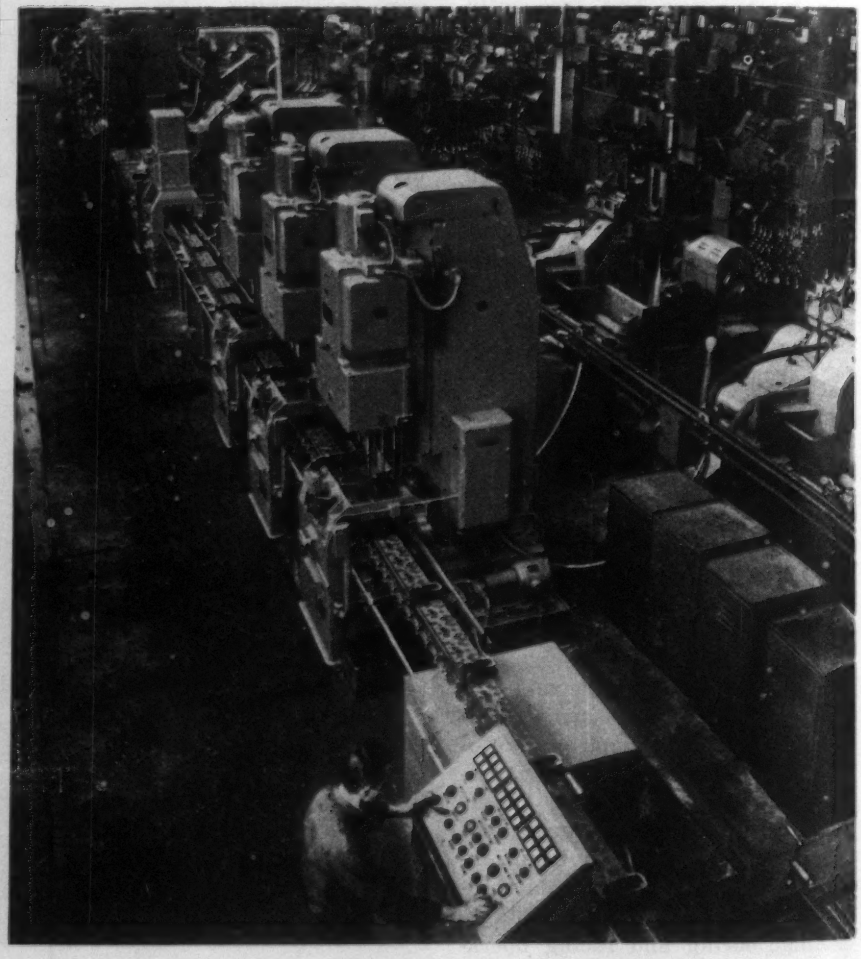
These workers do not realize that automation has made possible the economical production of such previous luxury items as automatic transmissions, high-horsepower engines, power brakes, power steering and many other products in the very lowest price automobiles.

These workers do not realize that the role of many working men as machine operators is evolving to one of skilled service and maintenance classifications. Automation is providing opportunities for skilled men to reap incomes higher than was ever possible as just machine operators.

Yet in Western Germany where wages are low and living standards are low, automation is welcomed as a better way to do the job. Many Germans are saying we did them a favor to bomb their plants during the war because their methods and manufacturing facilities were getting obsolete.

In Western Germany where the luxuries of every worker in this country are conspicuously absent, automation is welcomed as a means to better and cheaper products for more people.

If management would trouble to tell its story rather than defensively answering union charges, perhaps the enigma of misunderstanding surrounding automation would vanish.



Automated cylinder head line in Daimler-Benz factory in West Germany

The Motivating Force

In the gradual progress of automation the question often arises as to the motivating forces behind its advance. Actually, in our continuously improving standard of living and our dynamic economic system there are powerful forces creating demand for more automatic operations. An excellent example is found in the area of food production and processing.

Commenting on the significant achievement in farming where prices have gone down 24 per cent since their postwar peak while retail food prices have declined less than one per cent, Charles B. Shuman, president of the Farm Bureau Federation, recently stated:

"The benefits of automatic sowing and harvesting equipment, modern chemical fertilizer technology, scientific pest and and disease control are reflected in lower unit costs of things produced by farmers but are not reflected in the price of foods reaching the retail consumer. The savings tend to evaporate in the processing and distribution industries. And here, the biggest cost is labor—a cost which tends to rise at the same time as actual farm production costs decline. We do not expect, nor do we advocate, a reduction in wages paid to labor. Farmers do, however, have a right to expect the processing and distribution industries to adopt labor saving practices and methods similar to those which have come into use in other businesses."

The contention is that since the processing, marketing and transportation operations consume over 50 per cent of each consumer dollar for food production the answer lies in greater automation in the processing and marketing fields to match that accomplished on the farm. Thus, natural economic forces tend to establish a balance across the entire production cycle from start to finish.

Modernization with a greater degree of automatic operation will provide the needed economies in these areas. Real pressures behind such automation advance cannot long be ignored. The means are at hand and the desired results can be achieved.

EDITOR

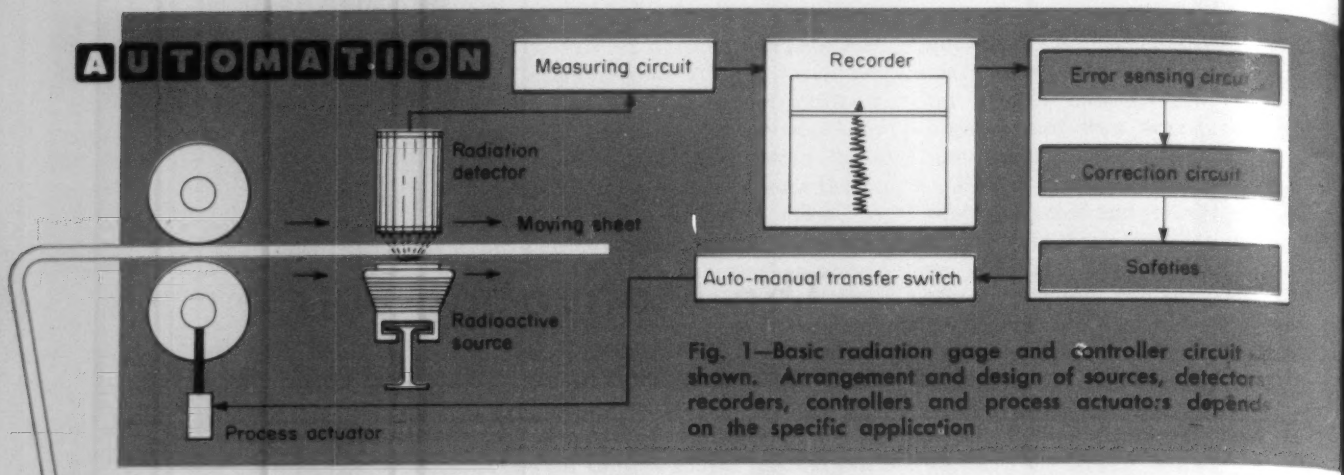


Fig. 1—Basic radiation gage and controller circuit shown. Arrangement and design of sources, detectors, recorders, controllers and process actuators depend on the specific application

CONTROLLING CONTINUOUS WEB PROCESSES

Radiation gage systems offer a solution to problems of gaging and controlling high speed processing of continuous sheet materials without contacting the material. Ratio of radiation absorbed to quantity transmitted accurately indicates the weight per unit area and thus the thickness of constant density sheets

By **NORMAN E. WALTERS**
Control Applications Engineer
Industrial Nucleonics Corp.
Columbus, O.

STEPPING STONE to automatic control in sheet process industries is a term some engineers have applied to isotope radiation gages. This analogy merits consideration when thought is given to the past efforts of engineers to design control systems for the paper, steel and rubber industries. Although various systems were designed to actuate roll mechanisms and stock valves, complete success was not achieved in trial installations because of a common failing—lack of an accurate, reliable sensing element to provide measurements upon which to base control action.

Thus, when radiation gages designed for industry were introduced a few short years ago, there was a ready-made niche for their application if they could prove their reliability, accuracy and economic feasibility. The subsequent performance of these instruments in industry and their wide acceptance indicate that a practical sensing element, so vital to automatic control in sheet processing industries, is available. A further indication is that radiation systems manufactured by Industrial Nucleonics Corp. are presently measuring—and in many cases controlling—ferrous and nonferrous metal sheets, tire fabric, boxboard, all types of plastic films and sheeting, paper, sheet abra-

sives, floor tile, gummed tapes, battery separators, felts, impregnated materials, mechanical goods, carbon paper, and cigarettes.

Before going into complete control systems, let's take a look at the characteristics of the gage itself. Basically, this instrument consists of an isolated radioactive material which emits energy, a radiation detector which collects this energy and transforms it into an electrical signal, and associated electronic circuitry to measure and present a continuous picture of the process on a recorder. The source of radiation is entirely independent of voltage variation and other external influences. Because there is a variety of radiation sources available with long industrial usefulness, a source may be selected to fit a given application. This permits accurate measurement of materials as light as cobwebs or as heavy as inch-thick steel plates.

Emphasis has been placed on radiation safeguards. Each source is fixed in a hermetically-sealed capsule which is locked in a steel source box. The source aperture is open only when the gage is in measuring position or standardizing. Should the window over the source be accidentally punctured, the source shield closes automatically and an alarm is sounded.

Sources in the measuring units may be purchased if the customer is set up to meet Atomic Energy Commission requirements or the source may be rented with responsibility for the source remaining with the equipment manufacturer. In the latter case, the supplier checks each source every six months. With thousands of units sold, Industrial Nucleonics has yet to have a source safety-failure.

Material to be measured passes between the source and the radiation detector without physical contact, and the emitted energy is either transmitted through or absorbed by the passing sheet. The transmitted energy is collected by the detector. The relationship of the radiation absorbed to the total radiation emitted by the source is proportional to the weight of the material. Absolute values of weight per unit area can then be continually presented on a precalibrated recording instrument. If the density of the product is known and remains constant, the gage can be calibrated directly in terms of thickness. Such a direct reading instrument presents the information in familiar units which can conveniently be translated into raw material usage, dollars, etc.

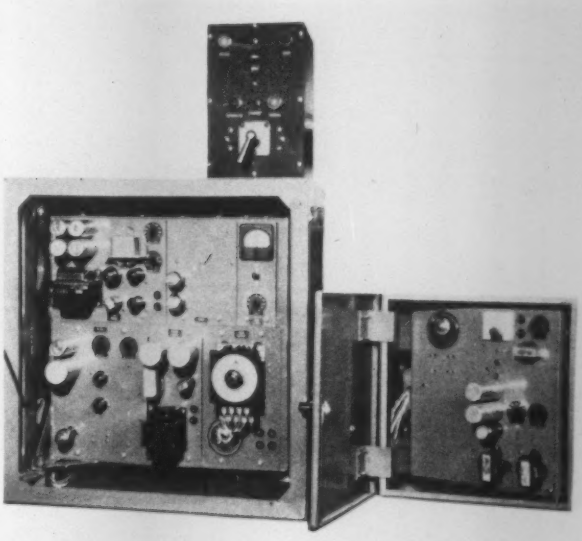


Fig. 2—One style electronic controller is depicted here. It has been used with radiation gages in several sheet processing industries

With some radiation gage instrumentation, the measuring circuit can be automatically standardized at regular time intervals to correct for environmental conditions. The weight of the air column between the source and detector is continually changing in most industrial applications due to pressure, temperature and humidity variations; and dirt and dust accumulate on the source and detector windows. By automatically standardizing

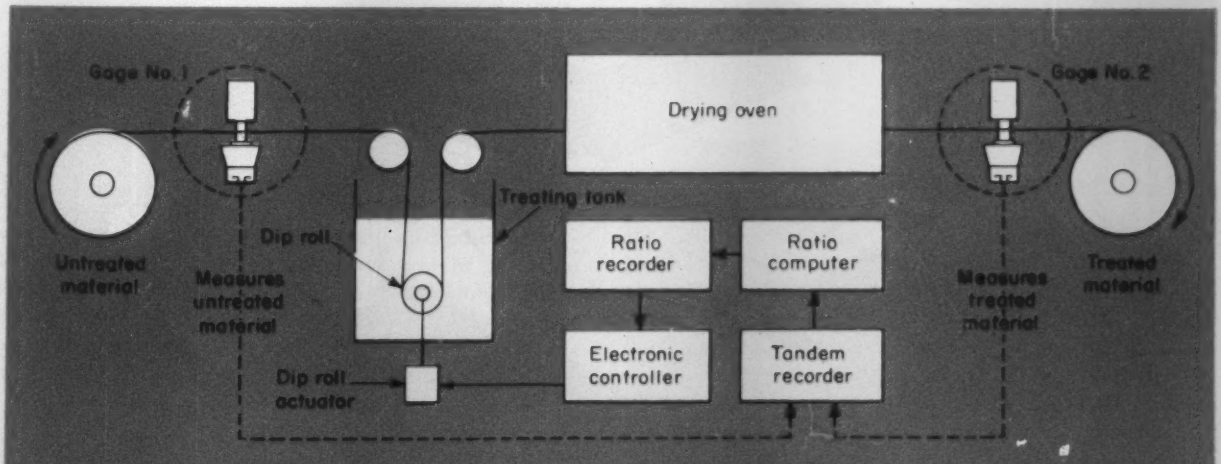
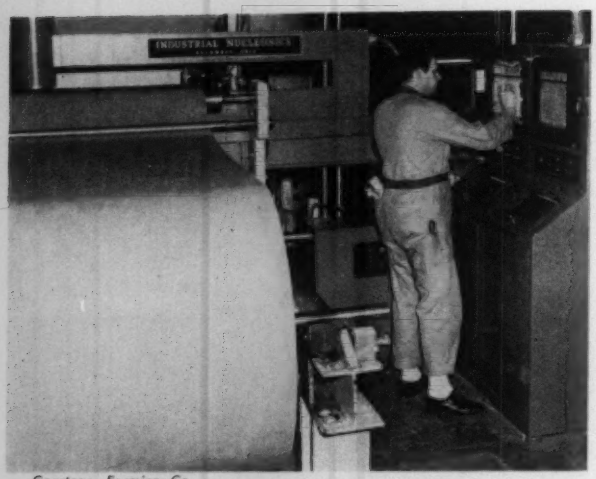


Fig. 3—Schematic diagram illustrates an automatic resin impregnation process for a paper-base plastic laminate



Courtesy, Formica Co.

Fig. 4—View of resin impregnation installation sketched in *Fig.* 3

for these conditions, without human supervision or effort, radiation systems can provide continuous readings of extremely high accuracy.

Since the measuring unit does not contact the sheet at any time, all types of sticky, sensitive materials may be measured with complete safety. Also, the rate of process speed in no way affects the readings of the measuring system, and scanning units have been developed that measure across sheets up to 300 inches in width. The configuration of the measuring unit is usually determined by the type of application.

▶ Companion Controllers

As shown in *Fig.* 1, the automatic electronic controller is part of a closed-loop feedback system. Points above and below specification where control actions are to be initiated are set on the controller. Thus, if the product varies beyond either point, an error signal is sent through the controller to the process actuator. There are several types of control actions employed in industry and the type selected depends upon the degree of control required and the various process parameters.

The electronic controller shown in *Fig.* 2 has been used successfully with isotope radiation gages for automatically controlling rubber, plastics, paper, metal, and impregnation processes. The fundamental elements of this controller include an error sensing circuit, correction circuits, and a transfer switch. In addition, safety features are incorporated to terminate automatic control action if highly irregular signals are detected by the sensing element or controller.

The error sensing circuit has adjustments for band-width sensitivity which determine the allowable deviation from the specification target before control action is initiated. The error sensing circuit also functions to detect the direction of the error. Correction circuits control the amount of the required correction and the period between corrections. With this system, over-correcting and

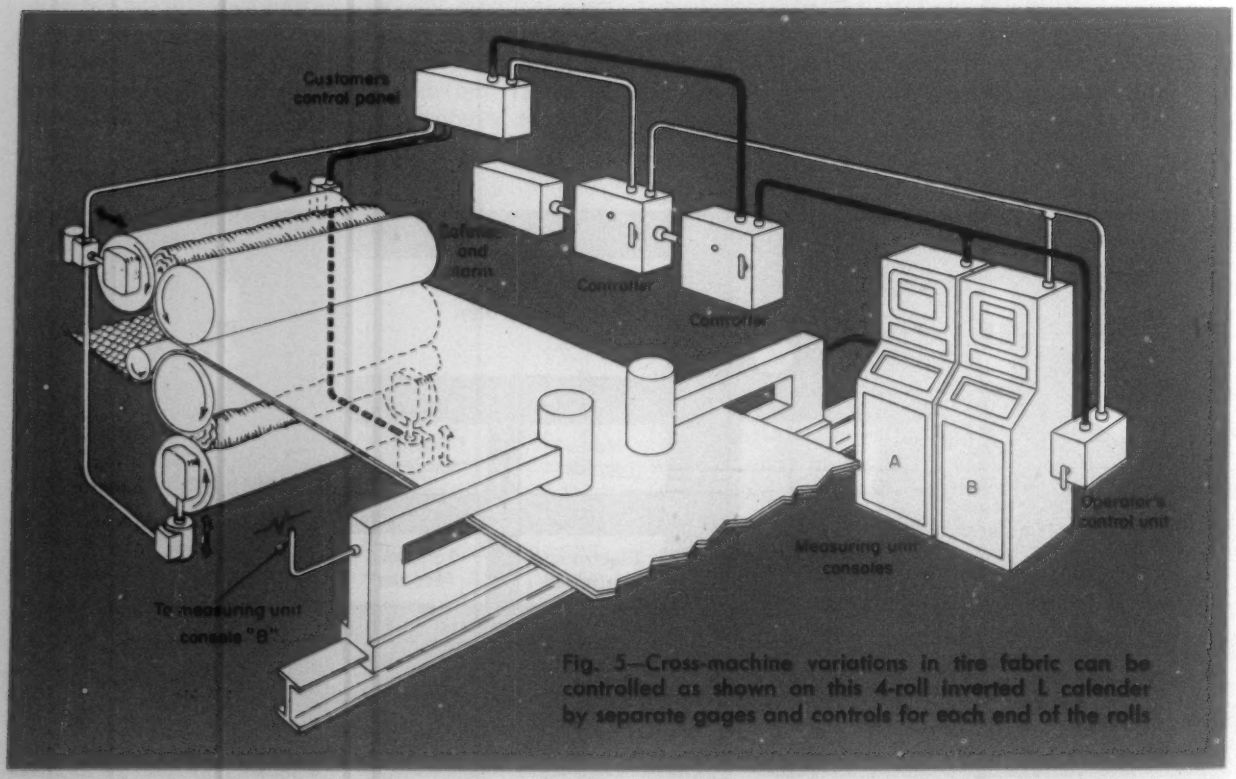


Fig. 5—Cross-machine variations in tire fabric can be controlled as shown on this 4-roll inverted L calender by separate gages and controls for each end of the rolls

hunting are minimized. Adjustments are available to select the period between corrections and to adapt maximum controller correction period to the individual process.

The control cycle continues until the process is operating within the preset limits. As in other automatic devices, safeties are desirable and believed to be a necessary part of a successful control system to insure against possible failure within the process machinery, sensing element, or automatic controller. If the controller correction period extends over a preset limit, if the error signal is excessive or if irregular signals are received, incorporated safeties will disengage automatic control and sound an alarm. The alarm calls the operator's attention to this irregular condition and he assumes manual control of the process. Automatic control can then be reinstated by the operator's transfer switch or reset button.

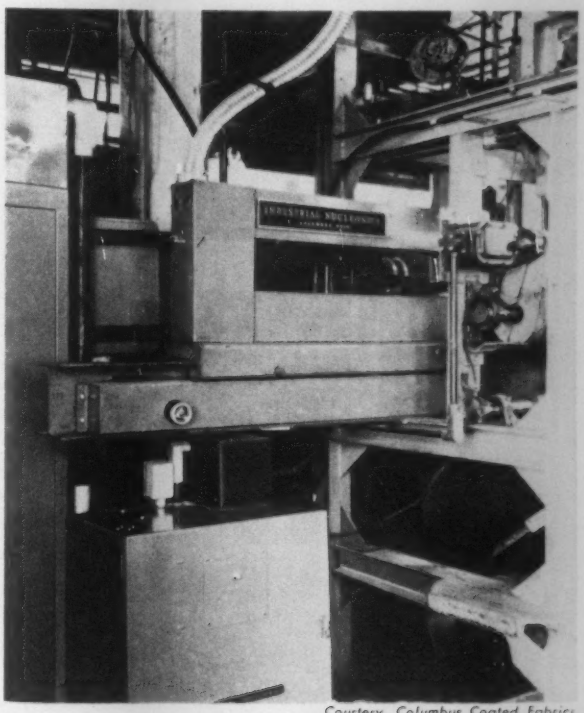
This form of process automation can be achieved in nearly every continuous sheet industry, but the degree of control will depend upon process variables, process machinery, processing and operating techniques, and allowed expenditure. In calendering and rolling processes one or more rolls may be controlled; on coater, impregnation and saturation applications, speed, tension, spreader knives, or coater rolls may be controlled; in paper or paperboard production the position of the stock flow gate can be changed; in extrusion processes, speed of extrusion may be controlled to yield uniformity in the final product. In some applications process changes may be necessary to provide better control. These alterations can usually be economically justified by advancing improved product quality.

▶ Production Applications

Paper Converting: On an impregnation process two gages and a controller are used to control the amount of resin deposited on the base material. As shown in *Fig.* 3, one gage measures and records the base material and the other measures and records the finished product. These readings are recorded on a two-pen instrument. A computing circuit continuously calculates the ratio of coating weight to the weight of base material plus coating. It is this ratio that is controlled by positioning a dip roll in a bath of resin. *Fig.* 4 shows a photograph of this installation.

Rubber and Plastics: Calendering processes, whether plastic or rubber, have individual characteristics which may require control of a single roll or a combination of rolls. Some calenders have the advantage of roll temperature control systems which minimize one of the important process variables.

In the four-roll inverted L type calender, shown schematically in *Fig.* 5, rubber is applied simultaneously to both sides of a rayon or nylon fabric. The end use of this material is for tire plies. Such plies must be uniform and adhere closely to specifications to yield a tire which will give economical service and safe operation to the motorist. Usually the fabric must be in the center of the rubber to give maximum insulation against cord abrasion.



Courtesy, Columbus Coated Fabrics

Fig. 6—Single radiation gage traversed from edge to edge of the web as on this plastics calender checks variations transversely and longitudinally on sheet

On this calender two gages and two controllers are arranged to control independently the right and left ends of the bottom and offset rolls. When the left gage and controller sense a heavy spot the left ends of the bottom and offset rolls are each closed an amount equal to fifty percent of the total correction. Control of this type corrects for machine and cross-machine direction variations and is possible because each side of each roll is

Courtesy, S. D. Warren Co.

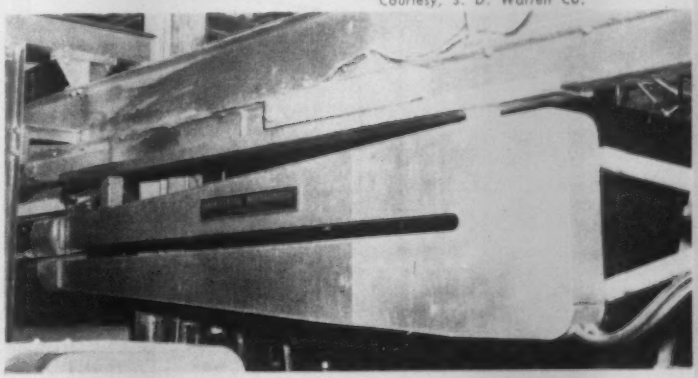


Fig. 7—Scanning type system on this paper-making machine is used to obtain average measurement values for controlling the stock gate

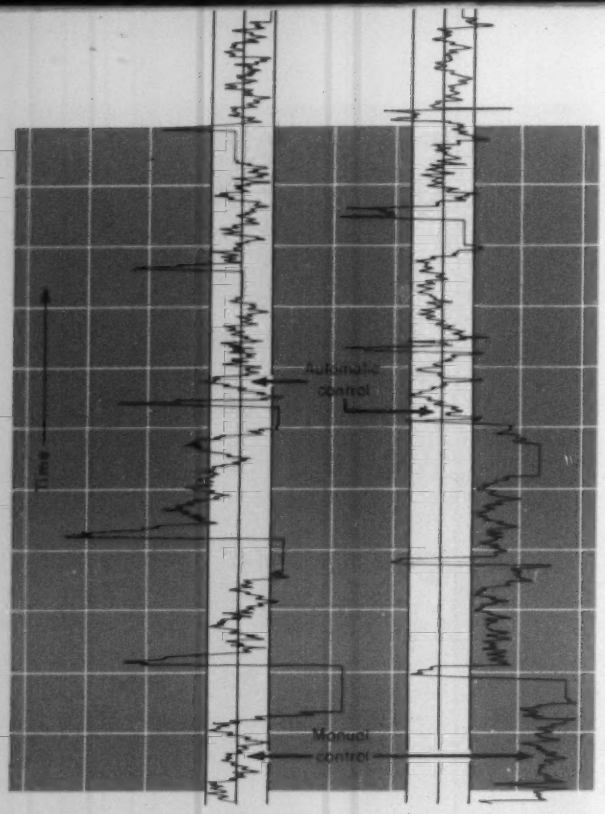


Fig. 8—Traces from the recorder on a steel rolling installation give a comparison of results obtained by manual control and by automatic control

individually motorized and the roll loading conditions are similar. Other control systems use reflection measurement directly off the calender roll to provide faster and closer control of the rubber on each side of the fabric.

In rubber and plastic calendering operations having a single actuator, the entire top or bottom roll can be moved to produce a uniform sheet. This system provides for automatic corrections in the machine direction but holds the operator responsible for any cross-machine direction variations. Another system allows the radiation gage to traverse from edge to edge of the web and make adjustments on the corresponding side through appropriate motors or clutching systems. This provides an intermittent type of side-to-side control. *Fig.* 6 shows a single controller and gage now in use on a plastics calender.

Paper: Control of paper making processes provides an interesting study of an ancient art. In general, paper and paperboard processes are extremely stable over short periods of time, but over long runs the basis weight and sheet profile tend to drift away from specification due to changing process and stock conditions. It is these trends that are important to control.

A gage and controller located on the wet end of the machine can provide a system of automation which will detect and correct for errors in the minimum length of time. At this point, however, the moisture content may vary within a range from 50 to 70 per cent, causing the finished paper weight to vary accordingly. For an accurate finished weight measurement, a gage and controller should be located at the dry end. The gage shown in *Fig.* 7 is mounted on the finished end of a paper machine, and automatically scans across the web of paper. As the signals are received by the measuring system they are integrated into an average value. This value is sent from the automatic integrating system to the controller and corrections to the stock gate are made accordingly. The average of the profile is held on specification by automatic control, but the condition of the profile is determined by the operator's adjustment of the slice.

Steel: In controlling any process it is desirable to perform the control function as close to the initial processing stages as possible. In cold rolling steel it was determined that screw-down control on the first stand of a tandem cold mill smoothed the steel sheet out so that further reductions at

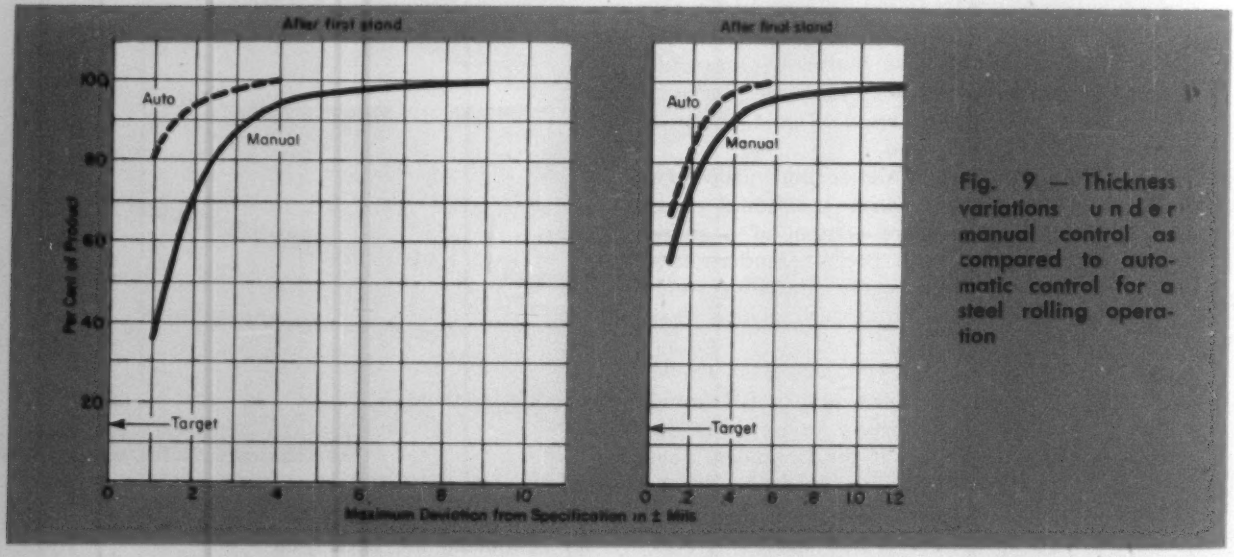


Fig. 9 — Thickness variations under manual control as compared to automatic control for a steel rolling operation

the other stands would be more uniform. The normal trend of a steel coil is from light at the beginning to heavy at the end. This is due to cooling of the strip and subsequent resistance to rolling as it is processed in the earlier hot mill stage. If these trends were not ironed out at the cold mill they would continue to exist in each subsequent processing stage.

▶ Results

Illustrated in *Figs.* 8 and 9 are charts which compare manual and automatic control of a tandem cold rolling steel mill. The controlled elements are the roll screw-down motors. As shown on the recorder charts, manual control was utilized on the first few coils and automatic control was turned on after a manual control pattern was illustrated. Quality improvements on rubber sheeting, tire fabric, plastic, paper, and metal have been similarly documented. In each case, automatic control decreased the total deviation from specification, brought the average nearer specified weight, and placed a larger percentage of material on target than could the operator with the use of the gage alone.

In addition to the quality improvements, the average weight of three of the products was decreased with automatic control. Actual dollar savings can be calculated for this elimination of excess weight. Other dollars can be added to the yearly profit statement by lowering excessive weight specifications on the basis of more uniform quality products.

The general acceptance of automatic controls by operating personnel has been excellent. The operator readily realizes that present controls cannot think, predict or completely replace his years of experience, but will aid him in performing his duties more efficiently. Such controls eliminate his routine process corrections, but call upon his experience and knowledge when more difficult problems are encountered. Control allows the operator to supervise his entire process more closely by eliminating a constant vigil at the control panel and permitting more time to supervise other personnel and processing variables.

As with the purchase of other capital equipment, the main criterion for the purchase of radiation gages and controls is the oft-repeated question, "What will it do for me?" Experience has shown that the more automatic the gaging unit (the more control provided), the higher the initial investment and the greater the expected return. Investment may run from $2500 for a manually adjusted gage with fixed-position measurement to $35,000 for a complete automatic control system for a cold roll mill in the steel industry. It has been the experience of Industrial Nucleonics that most installations* pay for themselves within a year's time.

The control systems described in this article are a foundation for the next step in industrial automation; a step which will take the data from the production line, analyze it in relation to process costs and market prices, and present its computation to the desk of management in the form of recommended courses of action.

*See "Continuous Gaging" AUTOMATION, Aug. 1954

GUARANTEED EMPLOYMENT

IN OUR DYNAMIC system of competition there is to my mind only one guarantee of steady employment. That is the guarantee of an annual increase in productivity which will give the American consumer, each year, more for his dollar than he was able to get the year before. That guarantee can be delivered only by the use of machines which multiply the output of the human hand and result in more output per man per hour.

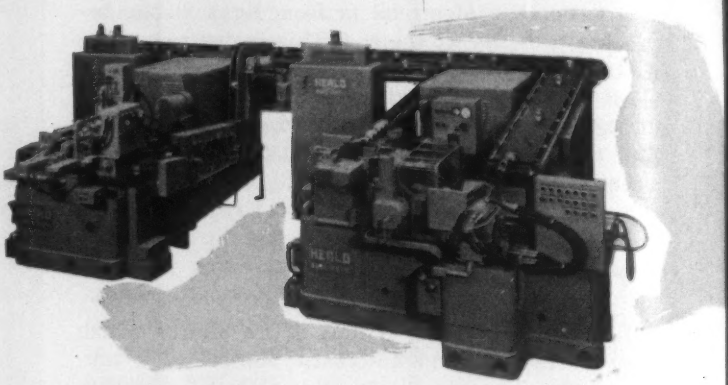
Consistent progress in automation is imperative as a foundation of employment continuity. The all important thing to remember is that under our competitive economy, this process cannot stop. Our entire economic system is geared to the assumption that each year we must provide better things for more people, at lower cost than we did the year before. We are the only country in the whole world that has founded an economy upon the assumption of perpetual progress; and that progress is in turn founded upon a guarantee of an annual increase in rate of productivity.

I think the time has come when it is vital that we be articulate and outspoken in our philosophy, which is that of maximum productivity on behalf of the standard of living and the full employment opportunities of all of the people of the country. We know that our philosophy has been proven by time and experience. The facts are on our side. It is up to us to present them to the American public. But we should do more than that.

That course of action is clearly indicated today. There are still in operation, in the metalworking plants of the United States, hundreds of thousands of antiquated, obsolete, almost worn out machine tools. These old machines represent high-cost production, by comparison to the productivity per man per hour that has been built into today's new models, largely by the progressive development of automatic controls.

These old machines are a drag upon the nation's economy. They act as a brake upon our cycle of perpetual progress. Everyone knows that sooner or later, they must be replaced. Most of them should have been replaced long ago. There never will come a better time to replace them than right now, before they do any further damage to our economy.

Here is one guarantee that can be made with full assurance: The machine tool industry can guarantee the metalworking industry of the United States that if it will undertake immediately a sound and comprehensive program of replacement of obsolete machine tools, the savings effected will total over a billion dollars a year, and, in addition, the net result will be an increase in overall employment.—*M. A. Hollengreen, president, National Machine Tool Builders Association at Westinghouse Machine Tool Electrification Forum*, 1955.



Segment of fully automated production line demonstrates adaptability of boring machines produced by the Heald Machine Co. to fully automated operations. Conveyorized work enters first machine for finish boring of wrist pin hole after which the part is automatically gaged and unsatisfactory work rejected. Parts are conveyed to second machine for elliptical box turning operation. All conveying, orienting, loading and unloading, flushing, and gaging are fully automatic.

AUTOMATION TODAY

MODERN TRENDS IN MACHINE TOOLS

"AUTOMATION TODAY" could be the theme for the impressive shows taking place in Chicago during the month of September. In many respects they are the harbingers of tomorrow's advancing automatic operations.

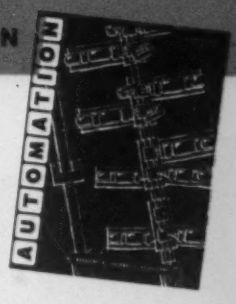
The Machine Tool Show sponsored by the National Machine Tool Builders Asociation is in a certain sense symbolical. To a very real extent, the unprecedented national prosperity of 1955 has been possible because of the capabilities of the products, new and old, manufactured by the machine tool industry. During a period of rising costs, the industry has proved itself time and again by delivering new and improved equipment enabling manufacturers to sustain active competitive and expanding markets.

To the industry itself, the show probably reflects the phasing-out of a period of activity characterized by replacement and expansion of plant and equipment. This replacement and expansion was unnaturally retarded during the war years. Under the impetus of sounder planning by management and an improved taxing policy which is better suited to more efficient replacement and expansion of equipment needs, the future should be tied more closely to technological advancements.

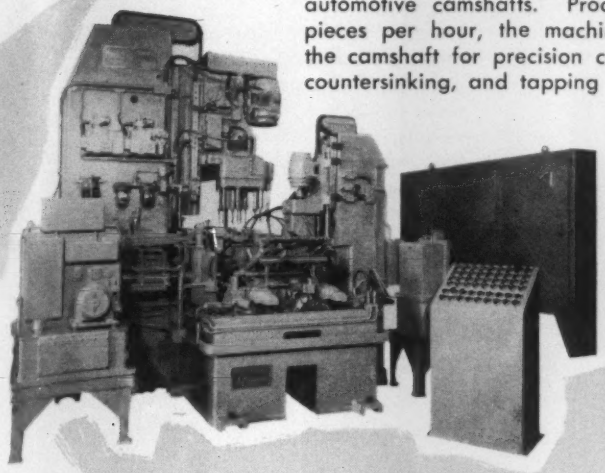
Certainly, in a competitive market, the generating power of research can be expected to provide for rapid advances in technology and greater emphasis on the factor of progressive obsolescence. As regards automation, it is natural, perhaps, in a business grouping as large as the machine tool industry that there is a variation in opinion as to the total need for completely automated machines. But an increasing number of machine tool builders are being impressed with the dangers of adopting too inflexible an opinion on the subject. That technological research within the industry, within customer plants, and within allied industries will bring new advancements which can effect today's practices appears to be a certainty. When this is considered in relation to statistics which indicate continually rising costs and a greatly expanding population, it is apparent that more and more individual production operations should fall within the area where automation is not only economically feasible but desirable.

The companies in the machine tool industry which have the most experience with automation find themselves responsible for machines grouped in systems of production as distinguished from isolated machines performing individual functions. These companies have and are developing valuable experience with related equipment, such as electrical and electronic controls, automatic gaging, handling and positioning devices to mention but a few. The importance of this expanded know-how is apparent when you consider this statement made by R. H. Sullivan, vice president, Ford Motor Co.—"But we had begun to exhaust the possibilities of improving our costs, productivity, quality control and safety merely by rearranging our equipment into new patterns. We discovered, for example, that it was becoming impossible to utilize the full capacity of modern machine tools, because men could not hand-load and unload them fast enough—" In a very real sense, then, an automated system represents an upgrading of the use of machine tools already in existence.

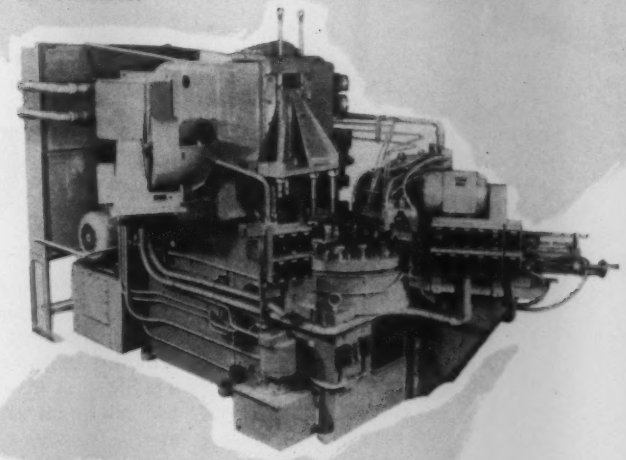
To adopt an analogy which has been used before in discussing automation, the various factors, such as handling, which limit the complete utilization of existing machine tool capabilities might be considered as an "automation barrier" which the individual tool builders must penetrate. The attendant problems in forcing this "barrier" cannot be minimized; however, experience indicates that it can be forced, which is after all the most signifi-



Special purpose 16-station transfer machine, designed and built by Krueger-Barnes Corp., for machining of automotive camshafts. Producing approximately 170 pieces per hour, the machine automatically positions the camshaft for precision cutting of keyway, drilling, countersinking, and tapping of numerous holes.

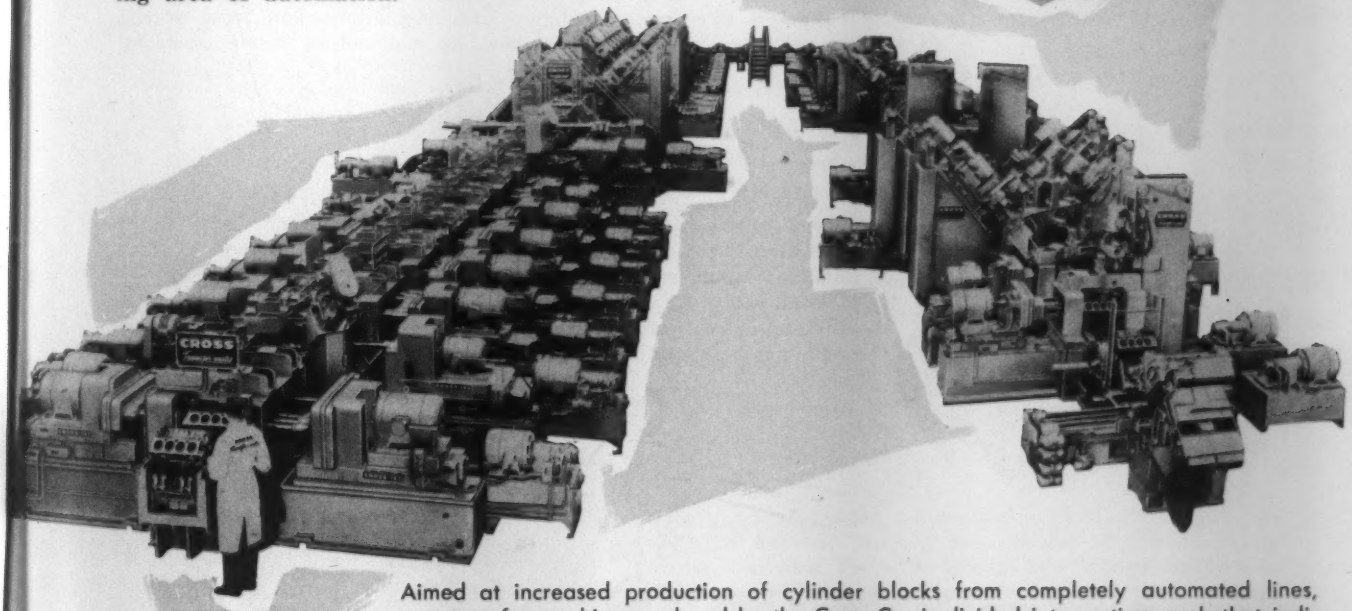


Advancements of interest include special machine tools which perform an assembly operation as well as metal removing. Designed and manufactured by American Broach & Machine Co., this six-station indexing table moves through an assembly station where a bushing is automatically assembled into the wrist pin hole of a connecting rod; in subsequent stations the bushing is burnished and the wall of the wrist pin bore is drilled for an oil hole.

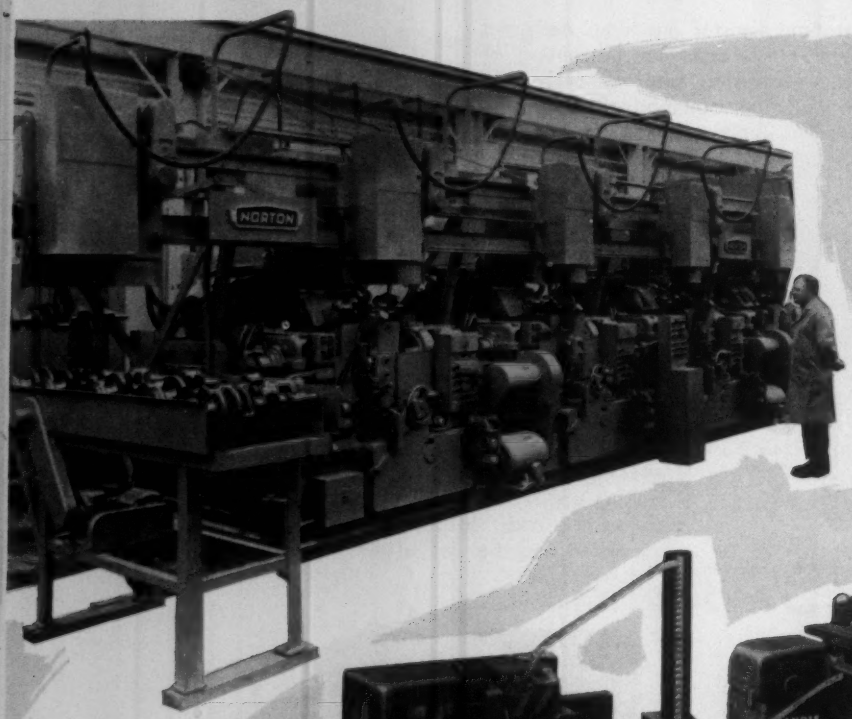


cant factor—the know-how exists; application awaits only the need which is sure to arrive.

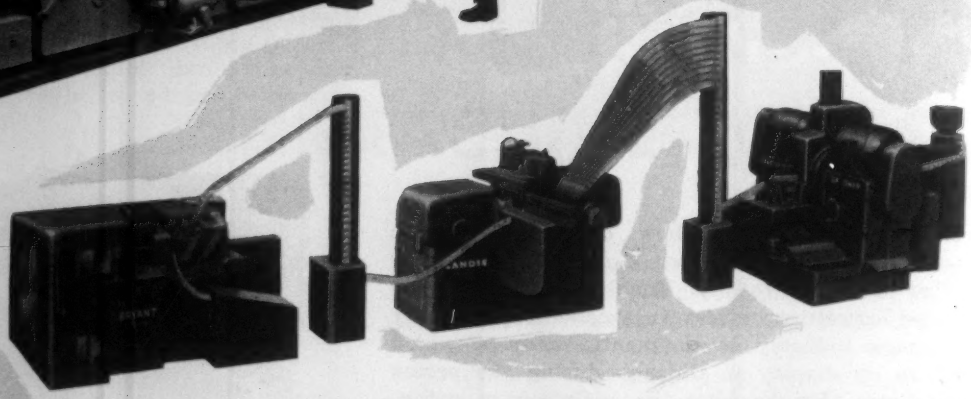
The occurrence of the Machine Tool Show and related expositions offers an excellent opportunity to review industry developments, many of which will be on display in Chicago during the period 6-16 Sept. Emphasizing the evolutionary nature of the technological advancements involved, the following pictorial review ranges throughout the machine tool field, covering both semiautomated and fully automated units, for a summation of some of the developments of interest in the growing area of automation.



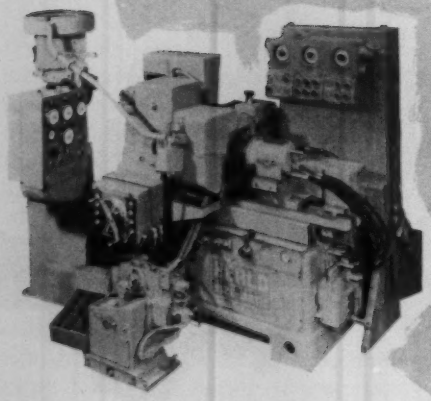
Aimed at increased production of cylinder blocks from completely automated lines, new transfer machine produced by the Cross Co. is divided into sections such that individual sections can be shut down without interfering with operations of the other sections. A bank of parts before each section provides a supply of work when any earlier section is interrupted. Machine control unit keeps count of number of machine operations involving each tool as a measure of probable tool life and as a guide to replacement of maximum number of tools at any one particular down-time.



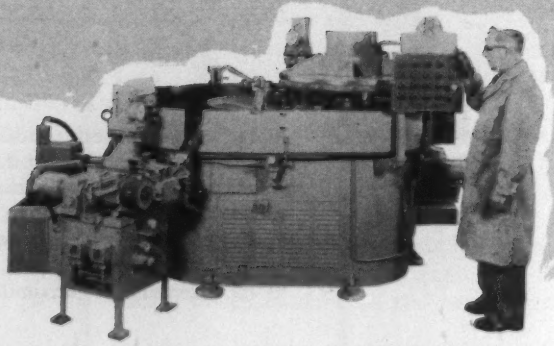
Transfer type grinder of Norton Co. produces substantial savings in crankpin grinding operations. The unit provides for automatic and continuous inserting, clamping, adjusting, controlling, gaging, wheel truing and transfer of parts being processed. An installation consists of one station per throw, and the machine cycle is such that any grinding station may be cut off if maintenance work is necessary at the particular station.



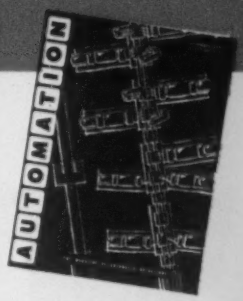
Co-operating in displaying an automated manufacturing line in production of ball bearing outer races are Landis Tool Co., Gardner Machine Co., and Bryant Chucking Grinder Co. The combination is designed to perform various grinding operations. Parallel sides of the races are ground to size in first machine; in the second operation 10 parts per cycle are stacked and ground for OD in centerless grinder; the third machine grinds the inside race diameter. Transfer between machines is completely automatic. Quality is automatically checked after each machine; resulting information from gaging raceway dimensions controls feed compensating mechanisms of the machines.

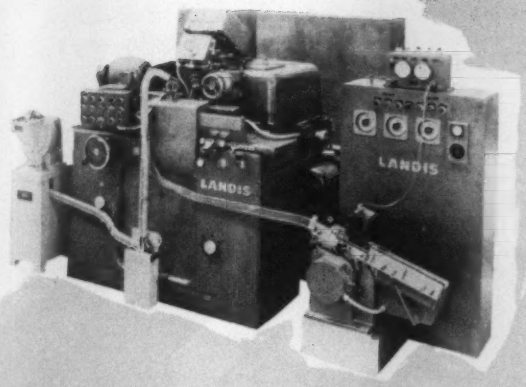


Internal grinder will be displayed by the Heald Machine Co. processing interrupted blind hole in automotive valve tappet bodies. Hopper feed with automatic orientation of the part is employed. Air gages in the unloading chute separate acceptable from unacceptable production and initiate corrections to maintain a uniform wheel dress at all times.

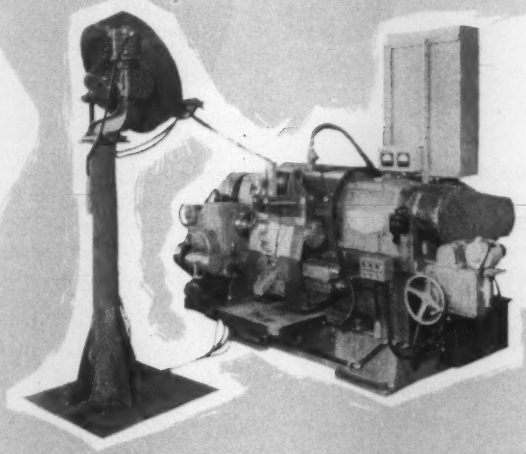


Establishing exact control surfaces for subsequent operations is of paramount importance to automated processing. Designed to produce 1200 gear blanks per hour, this abrasive machine manufactured by Micromatic Hone Corp. generates two parallel and flat end faces of the blank. Machine provides for automatic loading, continuous operations, automatic inspection, and compensation for abrasive wear.

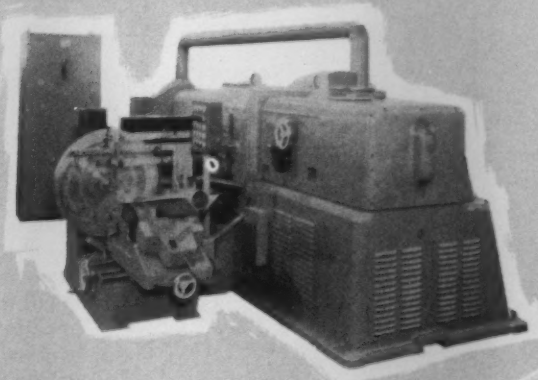




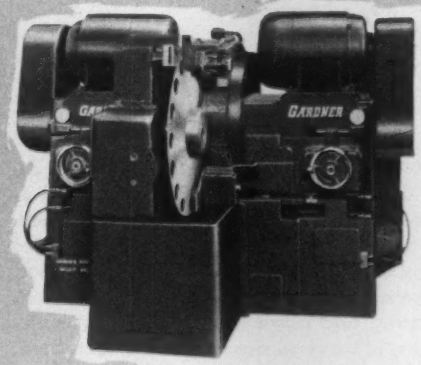
Features of grinder developed by Landis Tool Co. which provide for completely automated operations are: automatic work loading and unloading devices, hydraulically operated automatic wheel dresser, counter on dresser to control dressing intervals, dress pass counter for number of diamond passes over the wheel, compensating feed to hand wheel and special feed mechanisms and controls to accommodate feedback signals from quality control gaging device.



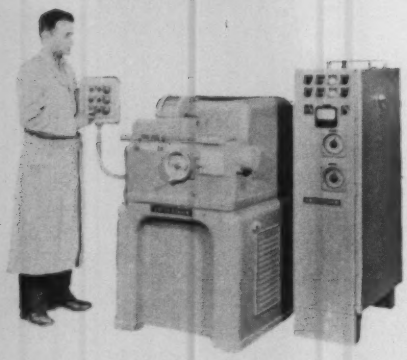
Quantity requirements permit development of special purpose machine tools such as this disk grinder for finishing both ends of steel piston pins. A product of Mattison Machine Works, the grinder receives pins from the hopper through a stacking mechanism where they are picked up automatically by a rotating carrier plate and clamped in hardened vees for grinding. Sizing devices continually gage work and actuate the feed to compensate for wheel wear.



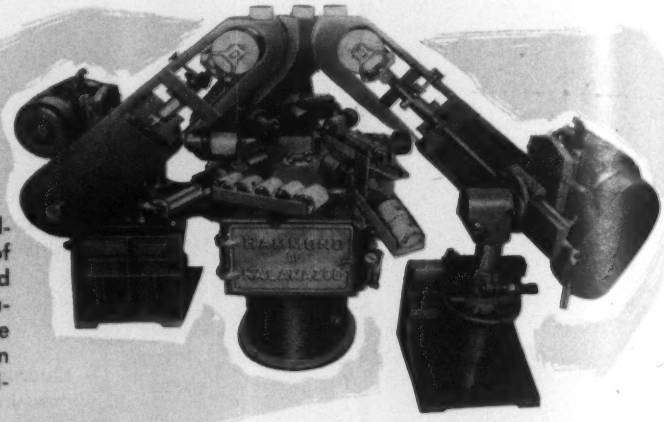
Simplified electromagnetic feeder, quickly adaptable to a variety of part sizes, is used on the horizontal double spindle grinder produced by the Besly-Welles Corp. Grinder is entirely automatically controlled including provisions for dressing each of the two disks with separate dressers through the control station.



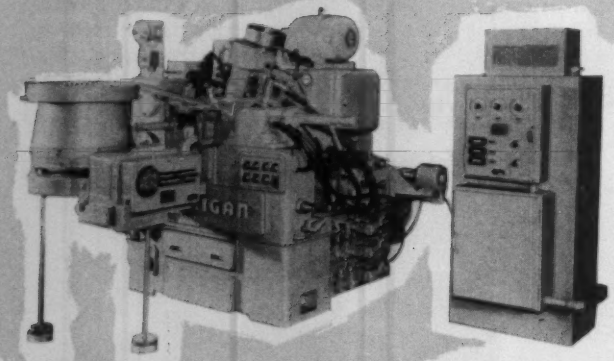
Pump gear blanks can be parallel ground at rate of 885 parts per hour on double disk grinder manufactured by Gardner Machine Co. Workpieces are loaded by hopper feeder and transferred to 18-station rotary carrier. Automatic size control is obtained by means of a Sheffield dual open jet system and single plunjet and gaging anvil. The measuring system is self-adjusting in accordance with predetermined settings.



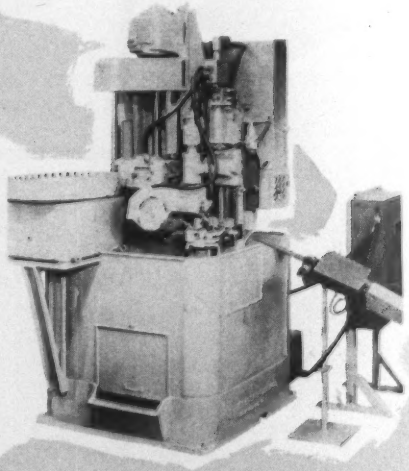
Incorporating an automatic wheel dresser compensator, a semiautomatic thread and form grinder developed by the Sheffield Corp. is designed for production of precision threads and forms on small parts. The grinding wheel can be formed by a Crushtrue device or by single point or multiribbed diamond dresser.



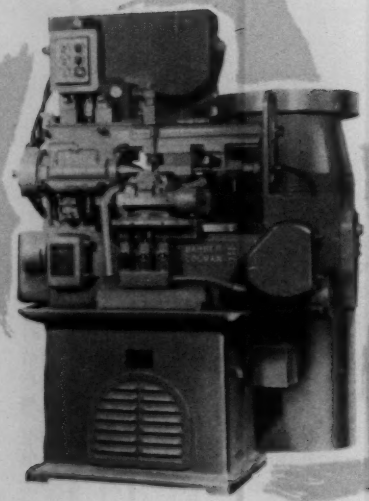
Versatility is achieved by Hammond Machinery Builders Inc. in a finishing production system by the use of a special indexing rotary automatic machine provided with pneumatic loading and ejection devices for completely automated operations. Illustrated are three abrasive belt units set around the indexing device in an operation involving the deburring of skirts of aluminum pistons.



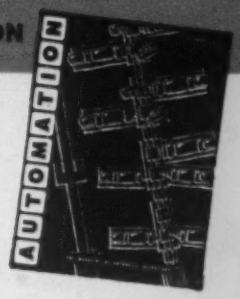
Completely automated gear production machine developed by the Michigan Tool Co. receives blanks from a hopper, hobs teeth, and inspects and classifies the finished work. Control unit adjusts hobbing machine based upon signals received from the gear classifier.

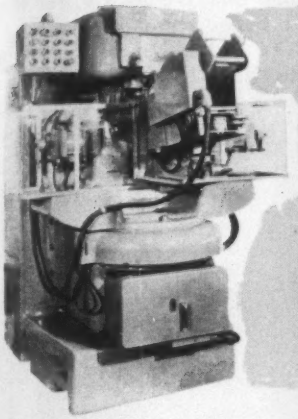


Single-spindle gear hobber of the Lees-Bradner Co. is a completely automated machine. Included are provisions for automatic loading of blanks from vibratory feeder, hydraulically operated tailstocks with expanding mandrel and electronic checker. The checker automatically inspects the pitch diameter and root fillet and adjusts and shifts the hob only when necessary; the checker automatically stops the machine should a predetermined number of consecutive gears be rejected.

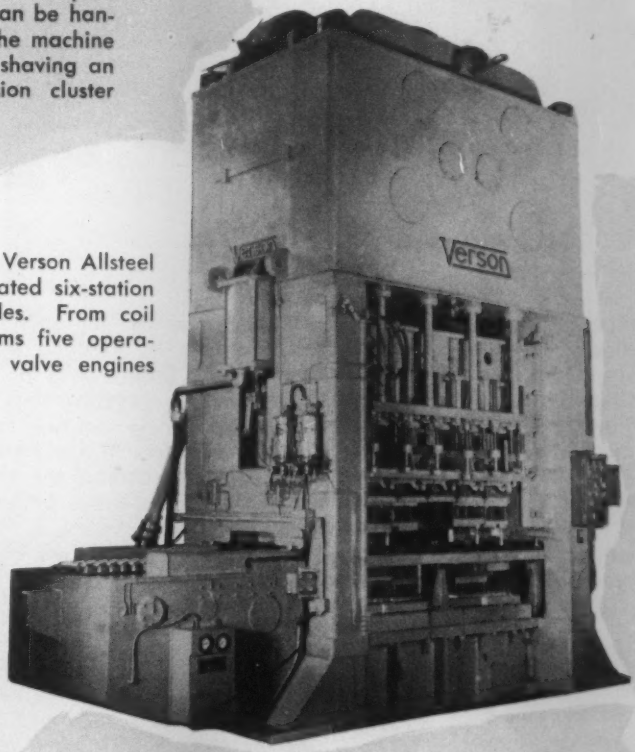


Introduced in the latter part of 1954, automatic hobbing machine developed by Barber-Colman Co. reflects variety of control mediums with which progressive companies are developing experience. The unit's automatic operation is achieved through a combination of mechanical, hydraulic and electrical components. Feed, index and hob speed are mechanically governed through a gear train; work slide movements, automatic clamping and arbor loading are hydraulically operated; and cycling and rapid traverse are electrically actuated.

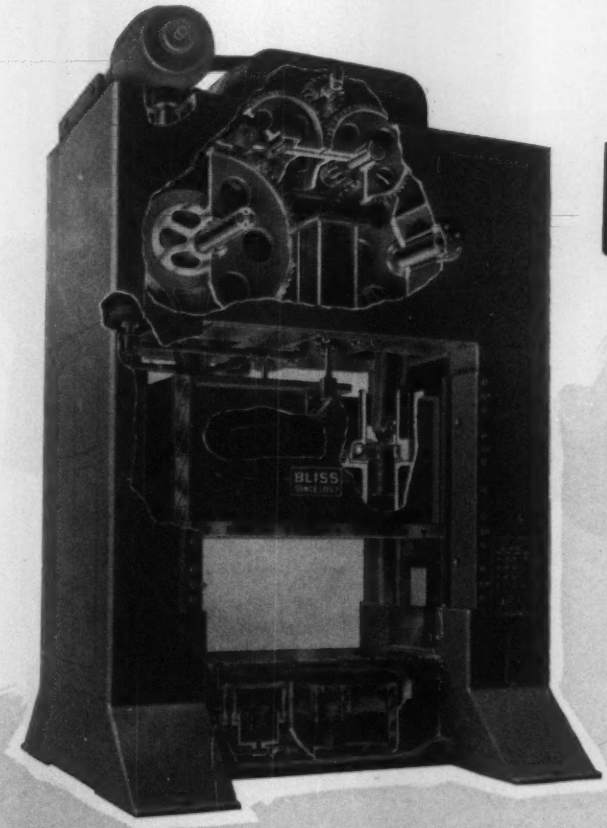




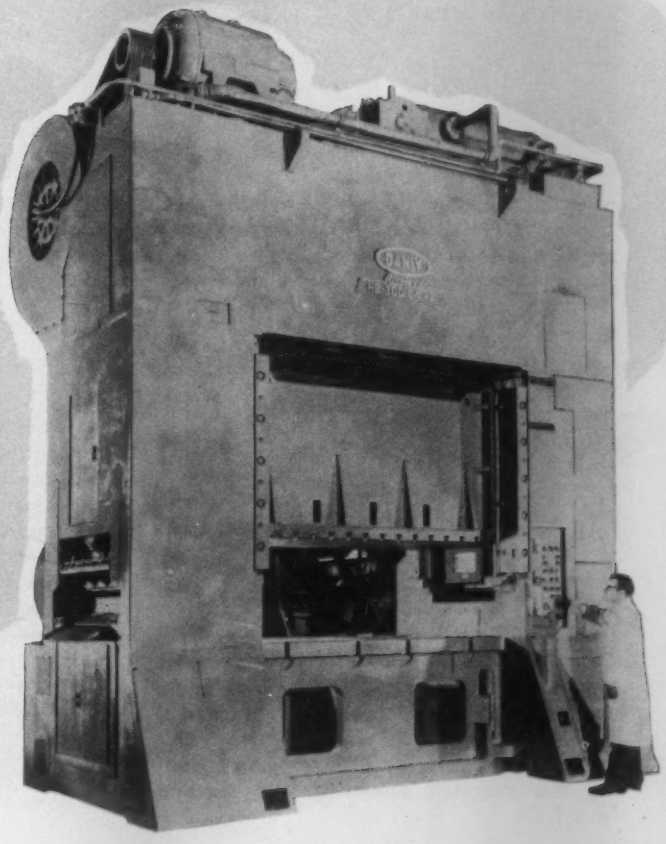
Gear finishing equipment to be displayed by National Broach & Machine Co. includes an external gear shaving machine equipped with an automatic loader. Illustrating the complex forms of work that can be handled automatically, the machine will be in operation shaving an automotive transmission cluster helical gear.



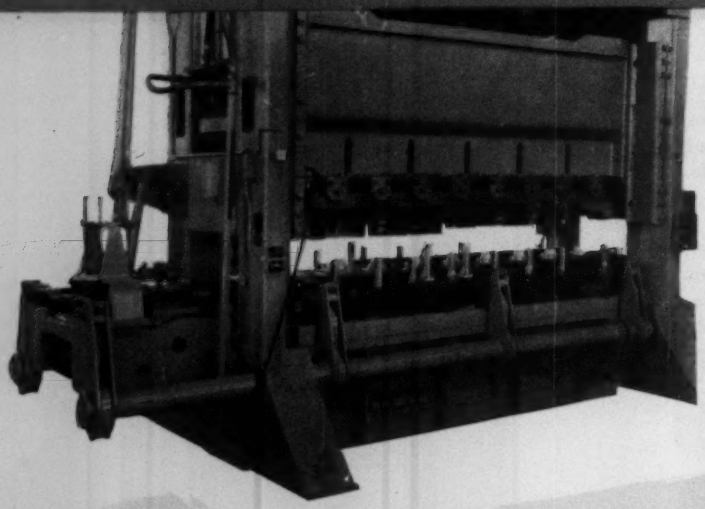
Eccentric type transfer press manufactured by Verson Allsteel Press Co. is equipped with mechanically actuated six-station transfer feed and individually adjustable slides. From coil stock, the 600-ton press automatically performs five operations to produce valve covers for overhead valve engines at the rate of 1080 parts per hour.



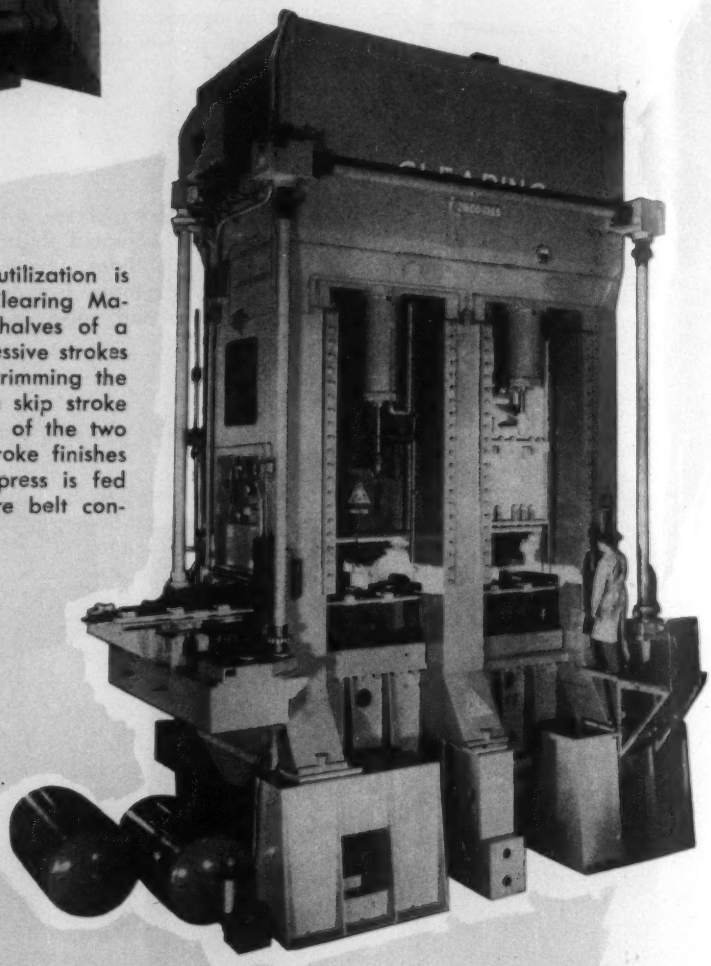
Completely packaged 250-ton straight side, single-action, full eccentric press is produced by E. W. Bliss Co. Anticipating application of automatic devices to press operation, the frames contain all necessary wiring, piping and controls.



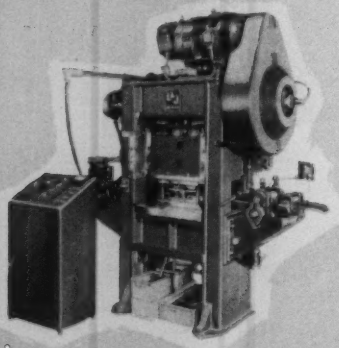
Automatic feeding device and recessed operator's control panel are enclosed in right upright of this 300-ton press produced by Danly Machine Specialties Inc. For further operating convenience, left upright contains automatic scrap cutter. These built-in features typify recent advances in large press design.



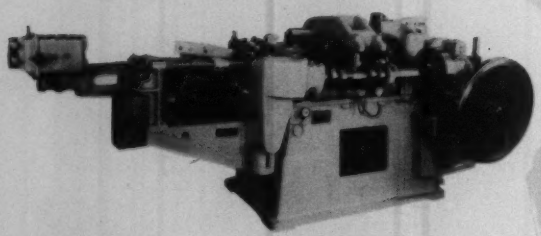
Close-up view of special purpose press designed by the Federal Machine and Welder Co. for the production of sealed beam headlight housings. Parts index through 14 stations, including eight work stations. Transfer feed *Left* to *Right* motion is obtained from takeoff at one end of press and *In* and *Out* motion from takeoff at other end of press.



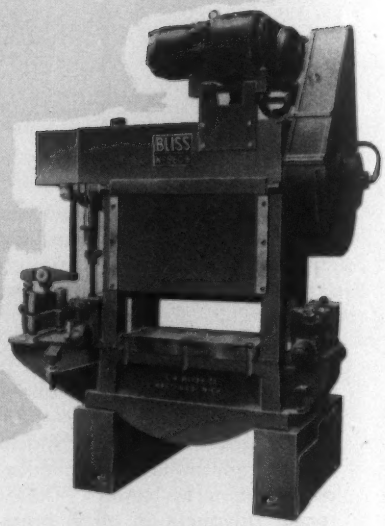
Influence of part design on maximum machine utilization is reflected by this special transfer press built by Clearing Machine Corp. for the General Electric Co. Basic halves of a refrigerator compressor housing are formed in successive strokes by two dies in 1200-ton section of the press; in trimming the basic halves to two different dimensioned parts, a skip stroke in the 400-ton section of the press permits loading of the two different trimming dies such that each alternate stroke finishes the flanges of two mating pieces. The transfer press is fed blanks from a rotary hopper; completed parts are belt conveyed to additional operations.



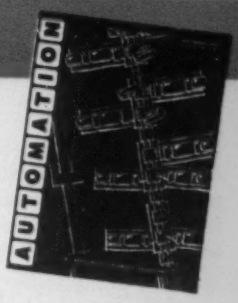
Straight side, high speed press to be displayed by the L & J Press Corp. will be operated with a progressive die for volume production of small precision electronic parts. Variable speed controls are available as extra equipment for this 20-ton model.

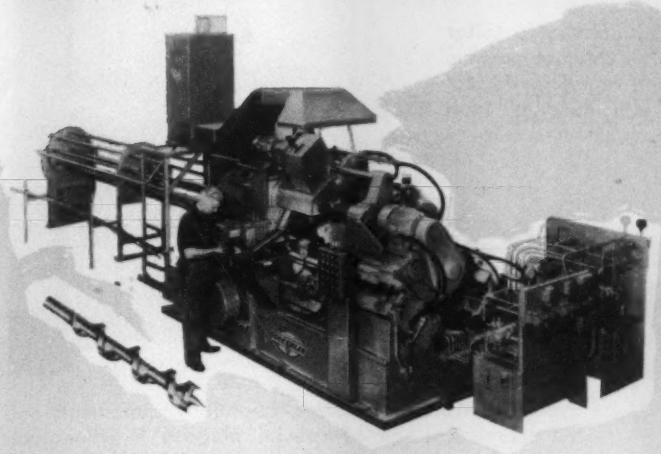


Incorporating a tapping unit on U. S. Tool Co. Multi-Slide stamping machine enhances the versatility for production by eliminating the need for a secondary tapping operation. The machine is designed to produce a completely formed metal stamping including the piercing, extruding and tapping of a hole.

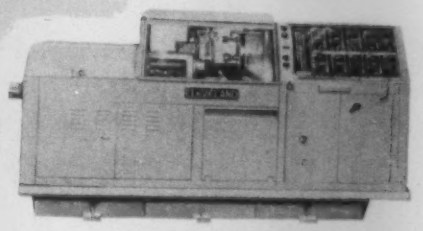


Controls for E. W. Bliss Co. high speed short stroke press have been removed from the press and are mounted on separate pedestal. Redesigned feed mechanism of pinion and rack design is used to feed the press capable of 450 strokes per minute operation. Integrated scrap shear shown is water cooled.

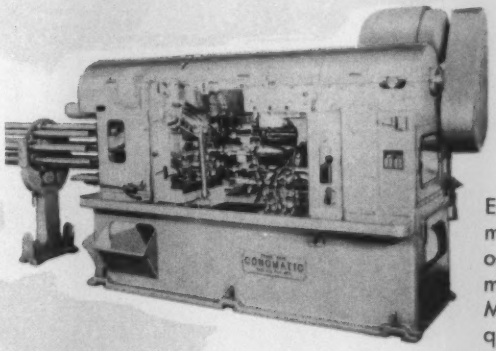




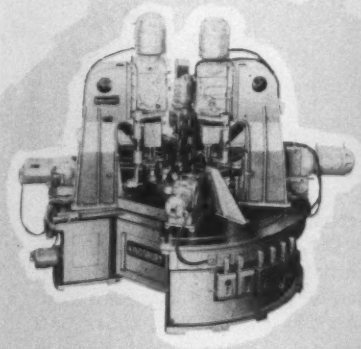
Special purpose machine tool developed by Greenlee Bros. & Co. will be exhibited at the show under full production making semifinished auger bits complete with a milled spiral and heading operations. Built by Greenlee to solve a production problem within its own plant, this is one of three such machines which is capable of producing auger bits from bar stock.



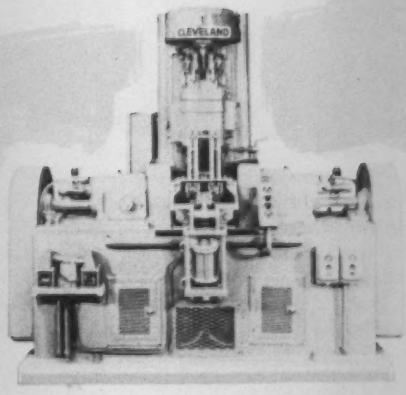
Single spindle bar automatic developed by the Cleveland Automatic Machine Co. features an electric feed drive and spindle speed control. No cam changes are necessary in adjusting the feeds of the turret tools. Feeds and spindle speeds for each of five turret positions can be preselected by setting dials and switches on the control panel.



Exemplifying the expanding use of standard machine tool forms to accomplish different operations, this eight-spindle automatic bar machine, produced by the Cone Automatic Machine Co., provides for heat treating and quenching in one of the eight tooling positions in addition to typical automatic bar machine functions.

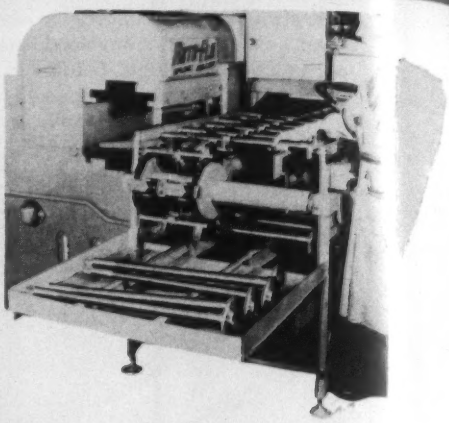


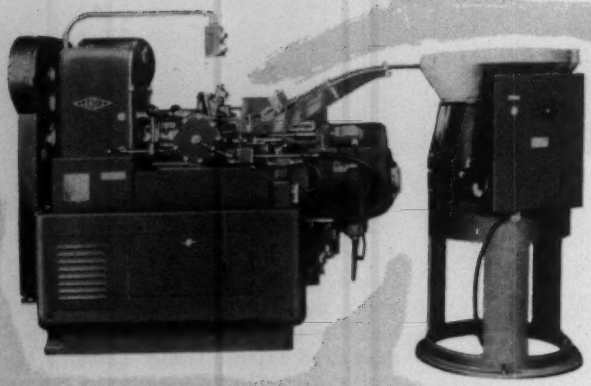
Combination of an automatic indexing machine with several automatic drilling and tapping units to form a special purpose automated machine will be exhibited by the Kingsbury Machine Tool Corp. The 100-inch diameter indexing machine has twelve rotating work holding fixtures; seven automatic drilling units drive 8 spindles for various drilling, countersinking, hollow milling, reaming and tapping operations.



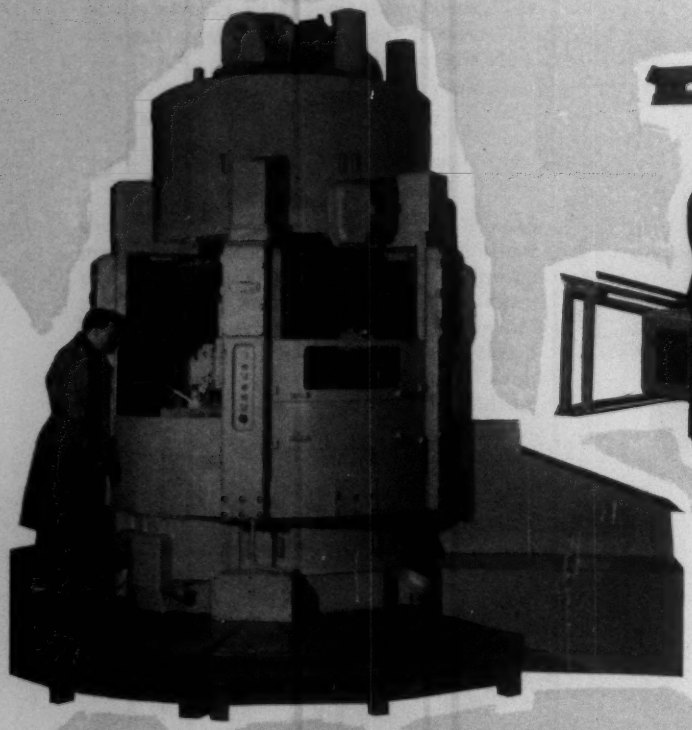
Designed for fast, accurate tapping of pipe fittings, the automatic fitting tapping machine manufactured by the Cleveland Tapping Machine Co. combines a lead screw tap feed with work feed devices and self-compensating holding devices for completely automatic operations. The machine will tap both holes in two ells or all three holes in one tee at one operation.

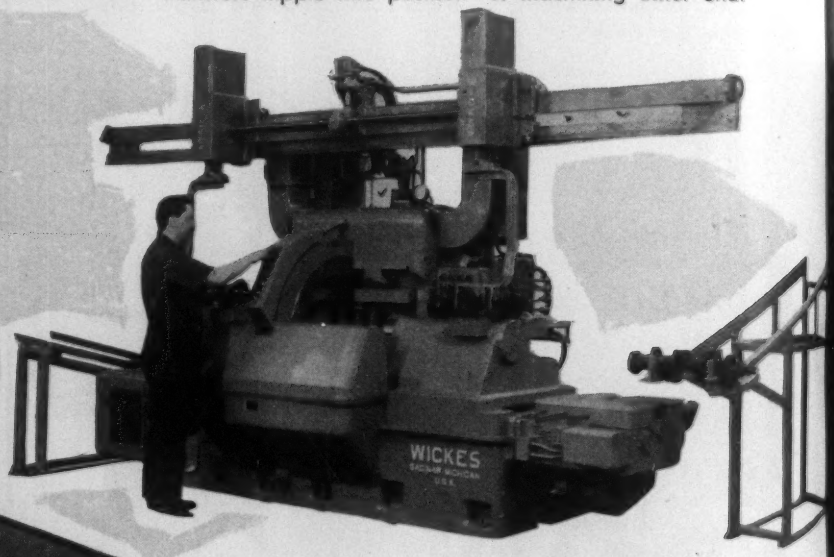
Involute splines are formed on steel shafts by automated spline roller produced by the Michigan Tool Co. The chipless machine tool is equipped with automatic loading and handling devices for production considerably faster than with machine tools which cut teeth in conventional manner.





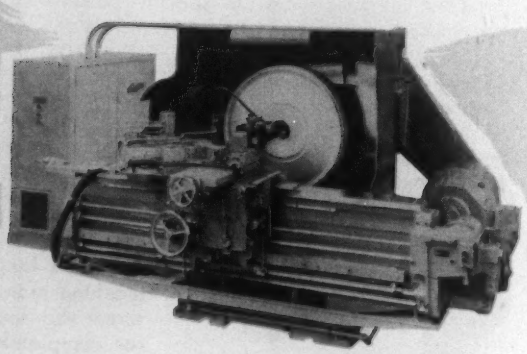
Even with variation in sizes, quantity requirements permit economical use of special purpose machine tools such as the automatic nipple threading machine designed by Landis Machine Co. Adaptable to a range of different nipple diameters, machine is fed blanks from a vibratory hopper for automatic continuous operation; blanks are threaded, chamfered and reamed on one end after which a mechanism automatically transfers nipple into position for machining other end.



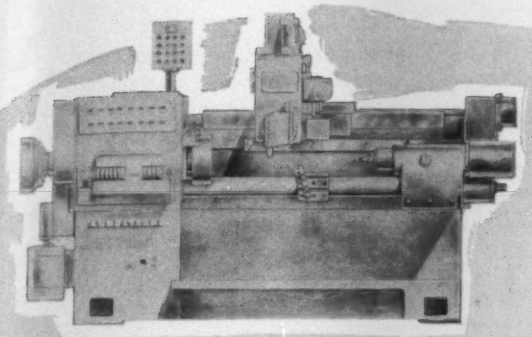


Center drive type crankshaft lathe manufactured by Wickes Brothers Div. of Wickes Corp. is fully automatic. Crankshaft is picked up from loading rack and automatically positioned between centers; machine proceeds to cheek, turn, space and fillet five main bearings, and to flange and stub ends simultaneously.

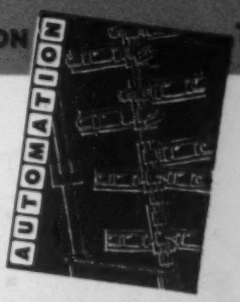
New line of multispindle vertical chucking machines is most recent development of the Bullard Co. Improved controls, feed mechanisms, and spindle carrier indexing are features of this new line of automatic machines. Accessory items include multipurpose heads, drill heads, tapping heads, automatic loading devices, automatic gaging equipment and chip conveyors.

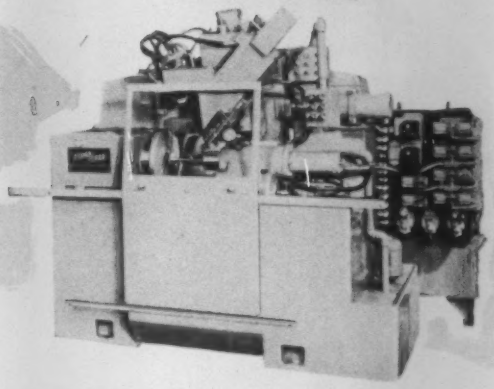


Tracer lathe specially designed for work with large diameters and short lengths is manufactured by Lodge & Shipley Co. This versatile model is capable of performing contour facing as well as contour boring or turning, all from one carriage.

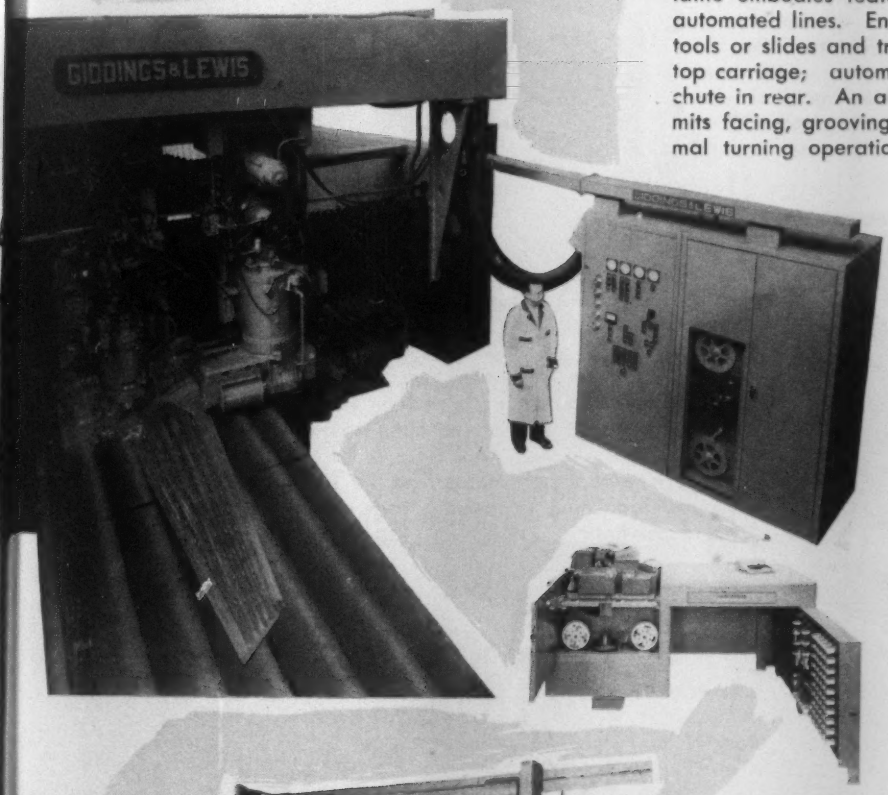


Representation of a multicycle lathe developed by the Sundstrand Machine Tool Co. The lathe demonstrated at the show will be provided with a punch card programming unit for control of a complete machine cycle. The two-position turret contains both roughing and finishing tools; lower carriage carries a shoulder facing tool. Three cuts can be taken on each of eight different diameters at eight different speeds in one automatic cycle.

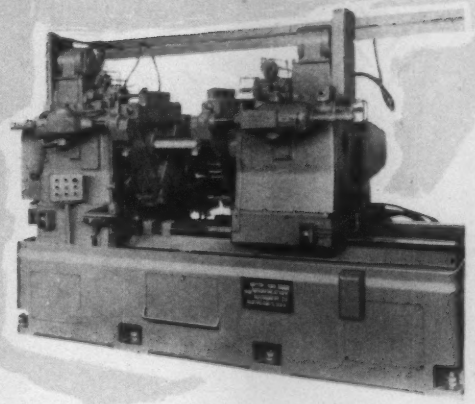




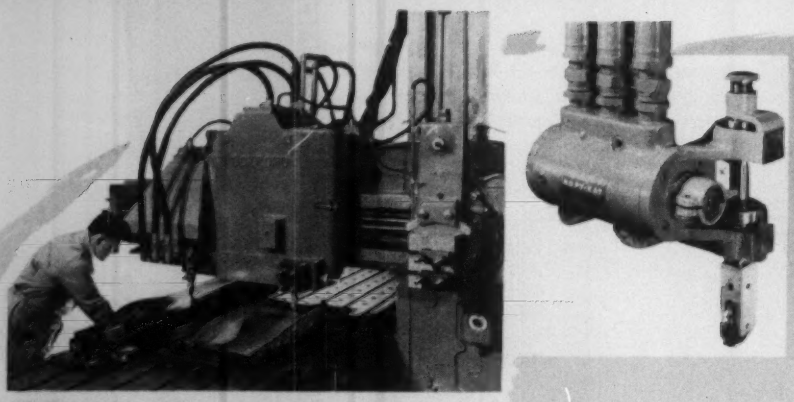
Designed by the Hydra-Feed Machine Tool Corp. and built by the Ohio Machine Tool Co., this new hydraulic tracer lathe embodies features which anticipate its application to automated lines. Entire front of machine is unobstructed by tools or slides and tracer slide and template are located on top carriage; automatic chip removal is facilitated by large chute in rear. An auxiliary carriage is available which permits facing, grooving or chamfering cuts in addition to normal turning operation.



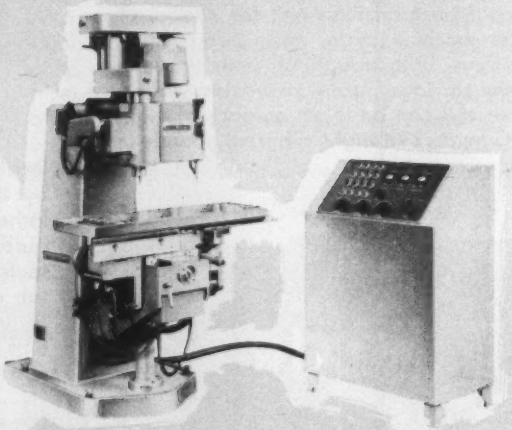
As a result of three years research at Massachusetts Institute of Technology and allied research at the General Electric Co., the Giddings & Lewis Machine Tool Co. has developed a complete automation system illustrated here with their spar and skin milling machine tool. System is most effective for applications involving variable axis, three-dimensional continuous machining but is available for heavy duty applications such as horizontal boring, drilling and milling machines, planer type millers and vertical boring mills. Precalculated data from drawings is punched into paper tape in numerical form, converted into time controlled continuous electrical signals and impressed on multichannel master magnetic tape. This tape is fed into a playback unit located with the machine and controls all axes and auxiliary functions of the machine tool automatically.



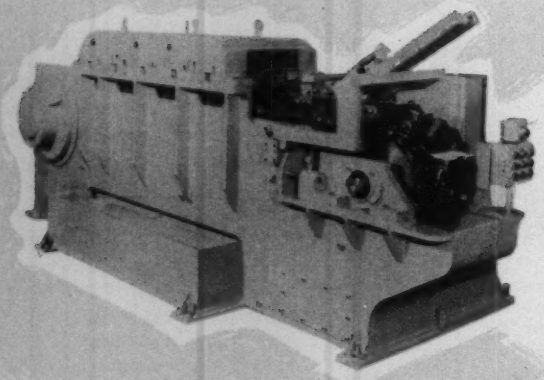
Representative of heavy duty milling equipment built by Motch & Merryweather Machinery Co. this special machine is used to accurately machine to length and center drill workpieces preparatory for further processing on tracer controlled and automatic lathes. Universal type machine has two triangular fixtures which index between three stations, the first of which is a loading station which can be automated.



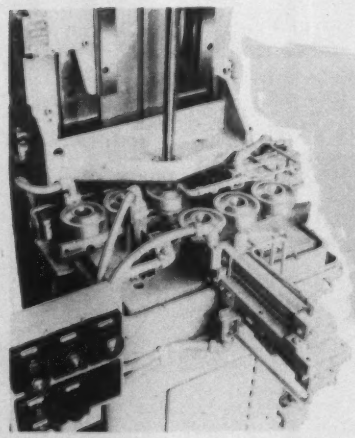
Hydraulic duplicating unit shown installed on an open side planer is an accessory item developed by Rockford Machine Tool Co. for use on their hydraulic shapers, planers, slotters, shaper-planers and lathes. Development of this type of sensitive but practical hydraulic device typifies the engineering know-how which will allow for further advancements in automation of machine tools.



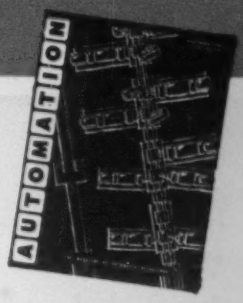
Unique tracer milling machine, developed by Pratt & Whitney Div., Niles-Bement-Pond Co. exemplifies new horizons being explored in the machine tool industry. Tracer point follows contours of model without contacting it mechanically. Variation in voltage across minute spark-gap between tracer point and electrically conductive model is amplified electronically and used to control magnetic clutches which feed the spindle quill and the traverse or longitudinal motions of the work table.

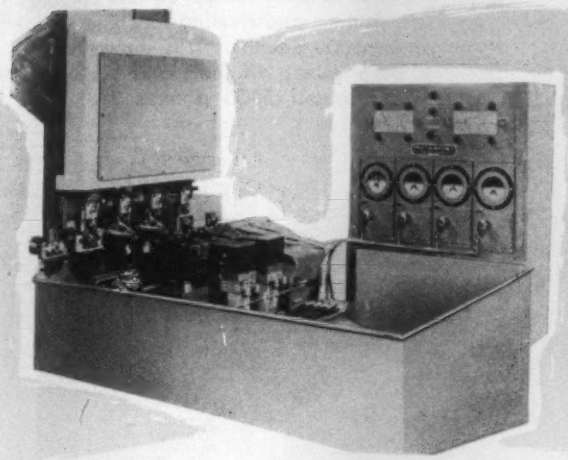


Feasibility of continuous broaching is proved by the successful operation of this type of machine manufactured by the Lapointe Machine Tool Co. A larger machine of the same general design, containing 24 fixtures, will be displayed broaching connecting rods at the rate of 1300 parts per hour.

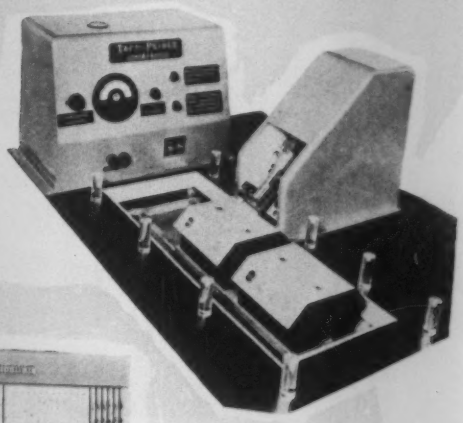


Effective handling mechanisms do not have to be complicated. Detail view of vertical type pull down broaching machine supplied by American Broach & Machine Co. shows loading and ejection cylinders and aligning means used in tying the automatic machine into a conveyor line. The machine runs continuously as long as parts are supplied by the conveyor line.



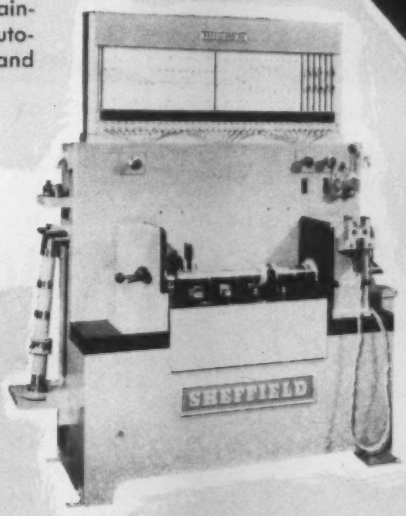


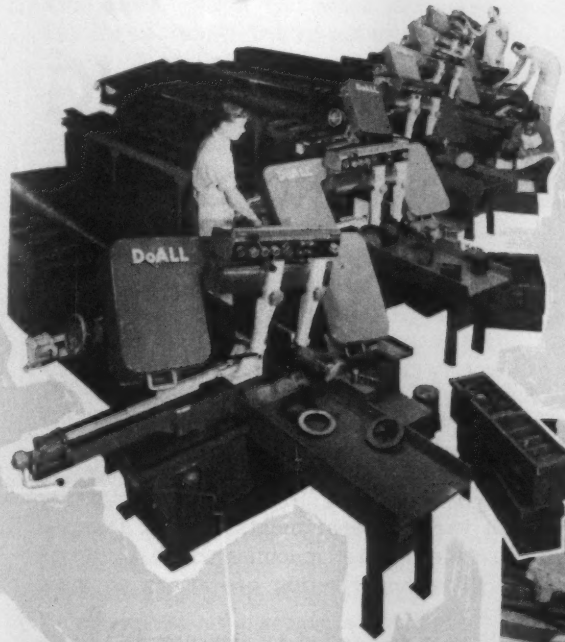
Machine control gage, produced by Pratt & Whitney Div., Niles-Bement-Pond Co., utilizes their standard back pressure gaging system. The unit when installed on a machine tool provides for in-process gaging and step impulse changes to machine controls for tool resetting; rejects will cause machine to stop. Installation on New Britain-Gridley automatic dual boring machine is illustrated.

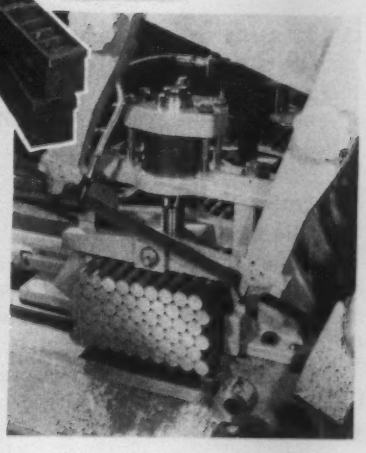


Model of automatic air gage which is manufactured by Taft-Pierce Mfg. Co. In operation gage is installed directly in automotive production line where ID of cylinder bores are inspected simultaneously after rough boring operation. Sensing an out of tolerance bore will cause boring operation to halt for tool adjustment.

Versatility of pneumatic gaging is reflected in this machine produced by the Sheffield Corp. Containing 36 columns, the unit is designed to inspect automotive crankshafts for 43 different dimensions and conditions, quickly and accurately.







New power saw built by the DoAll Co. is designed for automatic indexing of work to be cut. This model can be provided with a unique hydraulic nesting fixture to cut stacks of small diameter rounds; the fixture, synchronized with the sawing cycle, automatically unclamps as work advances and clamps for new cycle.

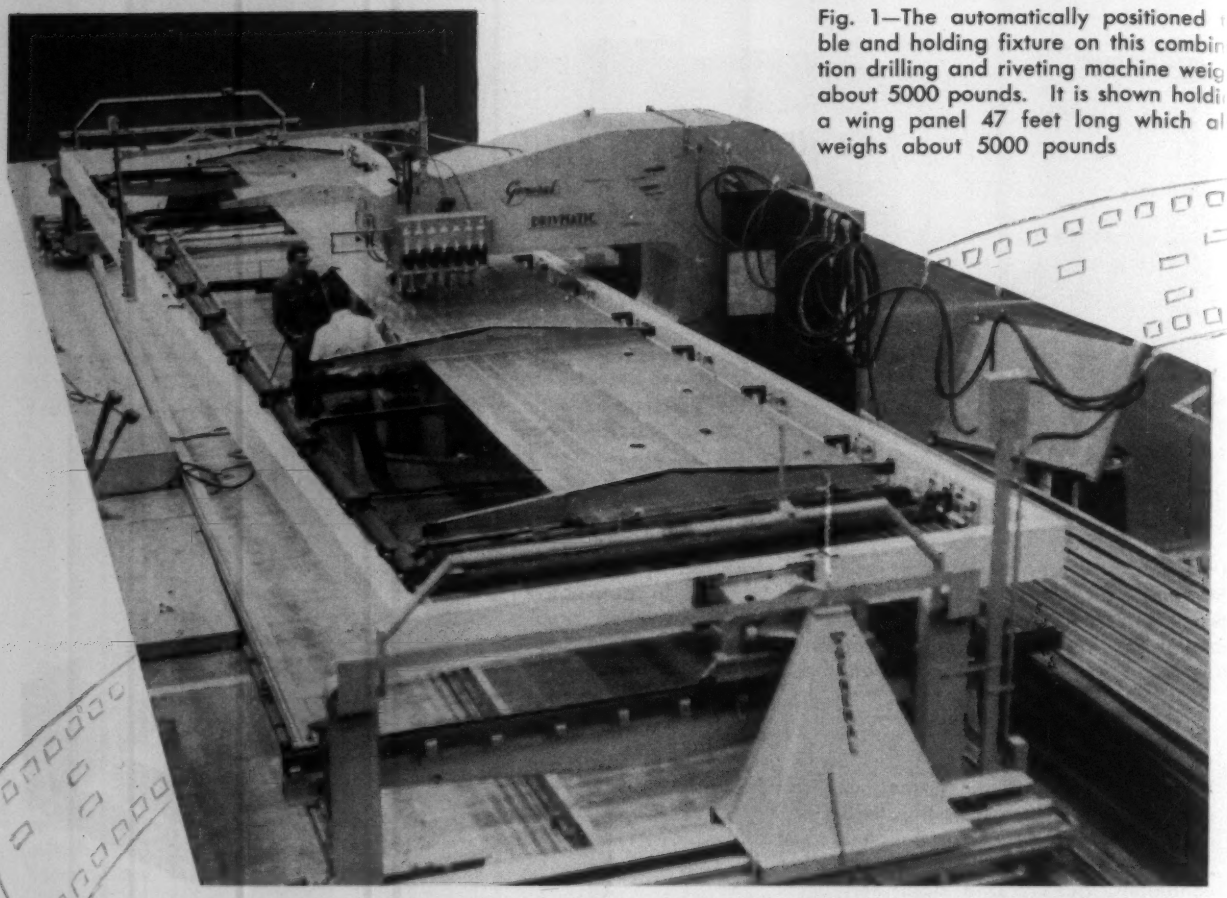


Fig. 1—The automatically positioned table and holding fixture on this combination drilling and riveting machine weighs about 5000 pounds. It is shown holding a wing panel 47 feet long which also weighs about 5000 pounds

AUTOMATIC POSITIONING

SPEEDS DRILLING AND RIVETING

AIRCRAFT MANUFACTURERS, in the building of air frames, do not have the production quantities to warrant automation in the same degree as is used for manufacturing in the automotive, electronic and household products industries. Yet we do make many millions of one thing—a little thing—holes for rivets and bolts—which we then fill up in assembly operations.

For years these processes were performed manually. Holes were drilled with hand drills or drill presses, bolts and rivets were inserted by hand, and rivets were headed with hand tools. Modern airplanes for their higher performance and greater efficiency have adopted the use of heavy tapered skins and large cross section stiffeners. In many cases it is no longer possible to drill the necessary holes manually or to hand buck the large diameter rivets required for strength and fuel tight joints.

In combination with these factors, production quantity rates for some airframes indicated that automated drilling and riveting operations should be considered. General Riveters Inc. working closely with various departments here at Douglas created a semiautomatic machine which performs complete drilling and riveting operations on wing and fuselage panels.

The machine is controlled by two punched tapes and consists of an automatic drilling and riveting unit with an automatically positioned work table. The tapes are standard 35-mm movie film and holes punched in the tapes allow brushes to close electrical circuits which operate simple electromechanical devices. Due to the heavy impact vibrations produced by the riveting cycle, vacuum tubes are

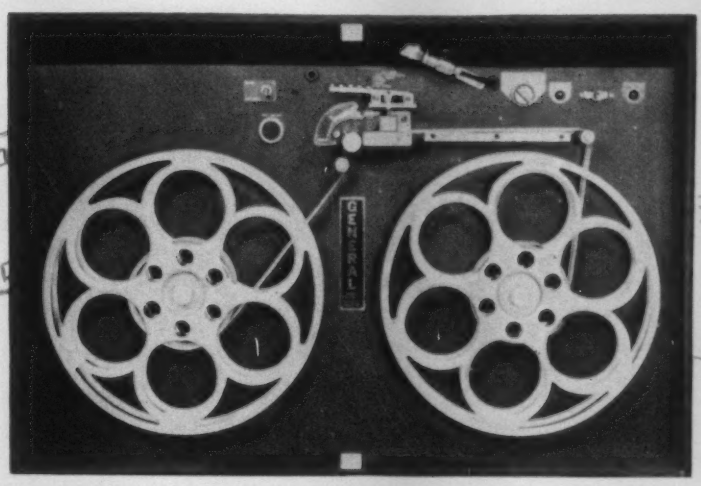


Fig. 2—Drilling and riveting operations and longitudinal movements of the table are controlled by this unit. Code holes are punched in 35-mm movie film using the keys at top center of picture. Prototype cycle is manually executed to punch the tape

By E. W. BERGERE
Chief of Production Methods
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not used on this machine, thus shutdowns because of tube damage are avoided. Movements of the table are powered by air motors operating through rack and pinion arrangements.

Positioning of workpieces is controlled by the two tapes. When the work has been positioned the tapes automatically actuate: (1) Clamping of the work to keep chips out of joints and produce fuel-tight joints without use of a mastic, (2) drilling of the hole, countersinking the top of the skin, (3) inserting of the rivet slug, (4) heading of the bottom, (5) heading of the top, and (6) milling of the rivet top flush with the skin for aerodynamic smoothness.

So that the table may be moved, mechanical obstacles such as the anvil of the riveting machine are automatically retracted. Repetitive and nonrepetitive patterns may be used, and the machine may be automatically stopped at the end of a row of rivets or at points where a change of rivet diameter or length requires the operator's attention.

Tape punching keys are incorporated into the control units. By using these keys and a prototype unit of the desired panel, an operator can generate new control tapes; he positions the panel by visual alignment using manual controls, then depresses the perforating buttons. Tapes may also be generated on a separate punching device which can be used at any desired location. For this unit mathematical tables are prepared for the desired movements. A key punch system and a mechanical counter are then utilized to translate the tables into codes punched in the tapes. Design changes or corrections of punching errors can be quickly made by covering the original holes with mending tape and punching out the new pattern.

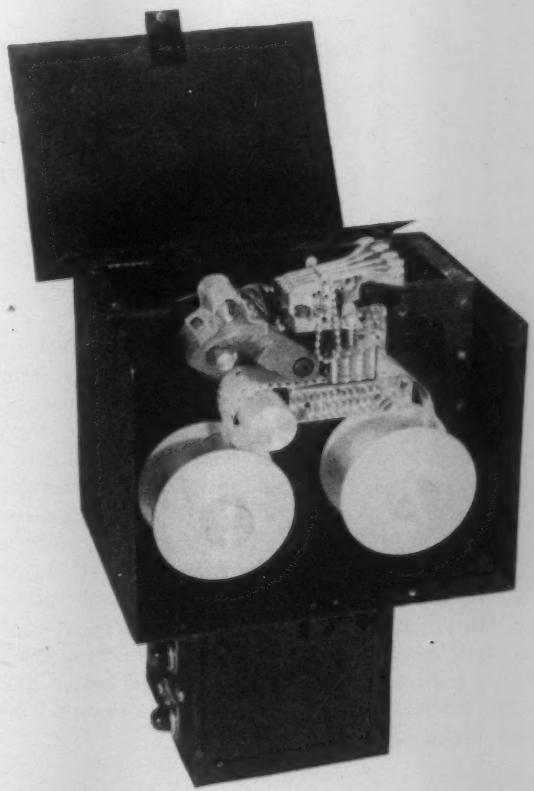

Fig. 3—Transverse table movements are actuated by a second tape running through this unit. Tapes are also punched on this unit by the operator positioning the table with manual controls then depressing punch keys

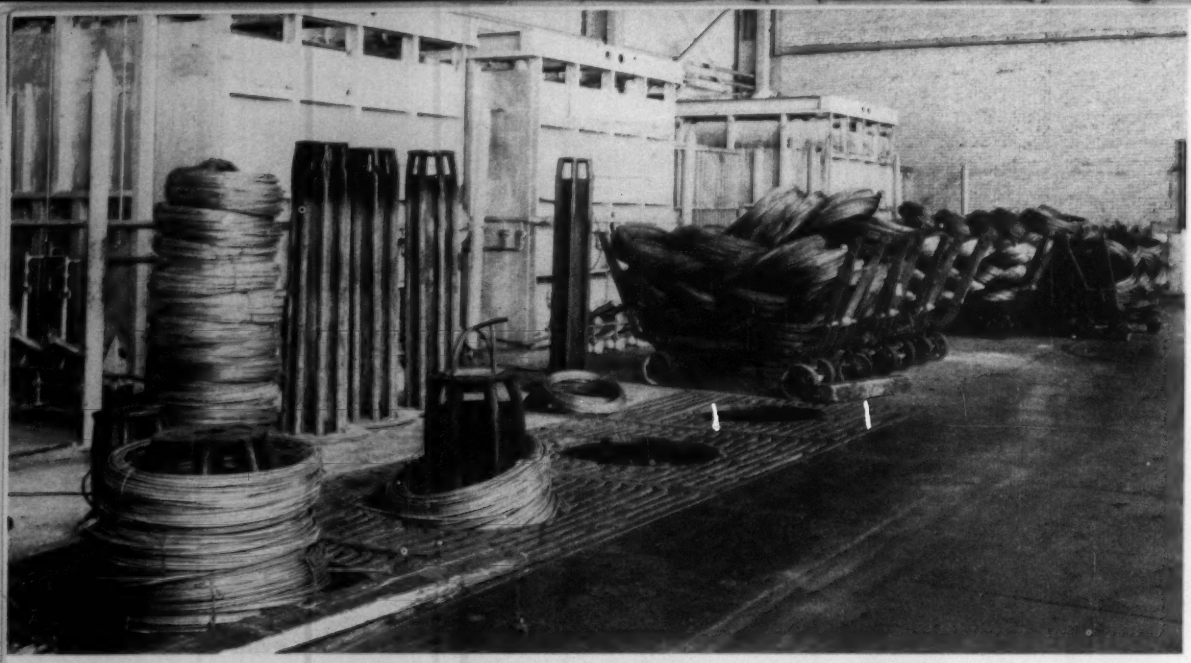

Fig. 1—Wire mill annealing department has a number of radiant-tube-type cover furnaces equipped with inner covers having sand or oil seals. An exothermic generator fired with coke-oven gas supplies furnace atmosphere. Accurate control of CO_2 content is necessary

WIRE MILL CUTS DECARB

WITH INFRARED ANALYZER

Chemical industry instrument applied in wire mill pays off in reduced rejects due to decarburization. Continuous record of carbon dioxide content in furnace atmosphere supply provides facts for control of atmosphere gas generation and use

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TODAY, AS IN THE PAST, the steel and chemical industries frequently find that many of their techniques, procedures and products are mutually adaptable. An interesting example of this is the way in which engineers in the wire mill of a large eastern steel producer have successfully applied infrared analysis to the prepared atmospheres in their annealing furnaces. This mill, using radiant-tube-type cover furnaces, *Fig.* 1, produces a wide range of wire stocks with carbon contents ranging from 0.06 to 1.1 per cent inclusive. End uses of these products vary from baling wire to automatic screw machine and ball bearing stocks, for which many specifications demand minimum surface decarburization.

Problem—Atmosphere Analysis

The protective atmosphere in which stocks are annealed is prepared in an exothermic generator burning coke oven gas. Preparation is thorough. Raw coke oven gas passes through a wet sulfur removal tower and flows through a monoethanolamine tower where carbon dioxide (CO_2) is removed by absorption. Next the gas is refrigerated and passed through activated alumina to reduce dew-point to the proper level. The gas is then ready for distribution to the annealing covers in the mill at a pressure of 15 inches of water.

In spite of this painstaking preparation, rejections due to decarburization on screw, lock washer, and ball bearing stocks sometimes reached levels considered objectionable by the company in the light of its high production standards. Alert to possible causes of the decarburizing action, process engineers and production men carefully checked such factors as dew-point and quantities of hydrogen, carbon monoxide, carbon dioxide and nitrogen present, finally narrowing the problem down to the trace of CO_2 in the gas. In moving to check the CO_2 factor, a measuring problem was

encountered because the small CO_2 concentration could not be continuously measured with high accuracy by the manually operated Orsat employed. They decided to use an industrial analyzer which would give a continuous, automatic record of CO_2 with the high degree of sensitivity and accuracy required. A Leeds & Northrup Infrared Gas Analyzer was the instrument chosen. Hydrogen in the gas prevented use of thermal conductivity gas analysis equipment for the measurement.

Answer—Infrared Analyzer

Operation of the infrared analyzer is based on the absorption of infrared radiation by compound gases, which may be briefly outlined as follows: When infrared radiation (radiant energy of wave lengths appearing in the electromagnetic spectrum just above visible light) is transmitted through a gas compound, the compound absorbs a characteristic pattern of certain wavelengths related to its molecular structure, and each compound has a different absorption pattern, see *Fig.* 2. It is this difference in absorption patterns that enables an infrared analyzer to analyze a gas mixture for one specific compound. Carbon monoxide, carbon dioxide, sulfur dioxide, methane, propane and ethane are only a few of the gas compounds which can be analyzed by this method. Oxygen, nitrogen, hydrogen, chlorine and all other elemental diatomic gases, however, do not absorb infrared radiation and cannot be measured by this system.

Each compound absorbs a maximum amount of radiation in its individual pattern when it is in a pure state. When the compound is part of a gas mixture, the amount of the absorbed radiation is less than the pure state maximum and in proportion to the percentage of the compound in the mixture.

Basic components of the infrared analyzer selected are a gas analyzer column and a continuous recorder. The analyzer column, *Fig.* 3, consists essentially of an infrared source, a sample cell, a sensitizing cone with two compartments, and a differential thermopile. In operation a sample of the gas to be analyzed is passed through the sample cell; a pure quantity of the gas compound to be measured, CO_2 in this case, is put into one side of the sensitizing cone; a non-radiation-absorbing gas is put in the other side of the sensitizing cone; and the infrared source radiates energy through the sample cell and both sides of the sensitizing cone to the differential thermopile.

This differential thermopile is a combination of two thermopiles, one under each half of the sensitizing cone, and each consisting of a series of small thermocouples which, when subjected to infrared radiation produce electromotive forces proportional to the intensity of the radiation. The thermopile under the pure CO_2 side of the sensitizing cone produces an emf which represents the maximum reduction in transmitted radiation due to pure CO_2. The thermopile under the other side of the cone generates a larger emf representing the lesser reduction in transmitted radiation due to the lower concentration of CO_2 in the test sample. By opposing these emfs, a differential voltage is obtained which is inversely proportional to the percentage of CO_2 present in the sample. As the per cent of CO_2 increases, the differential voltage decreases. The recorder is calibrated to indicate the percentage of CO_2 present in the sample. Absorption effects of other gas compounds present

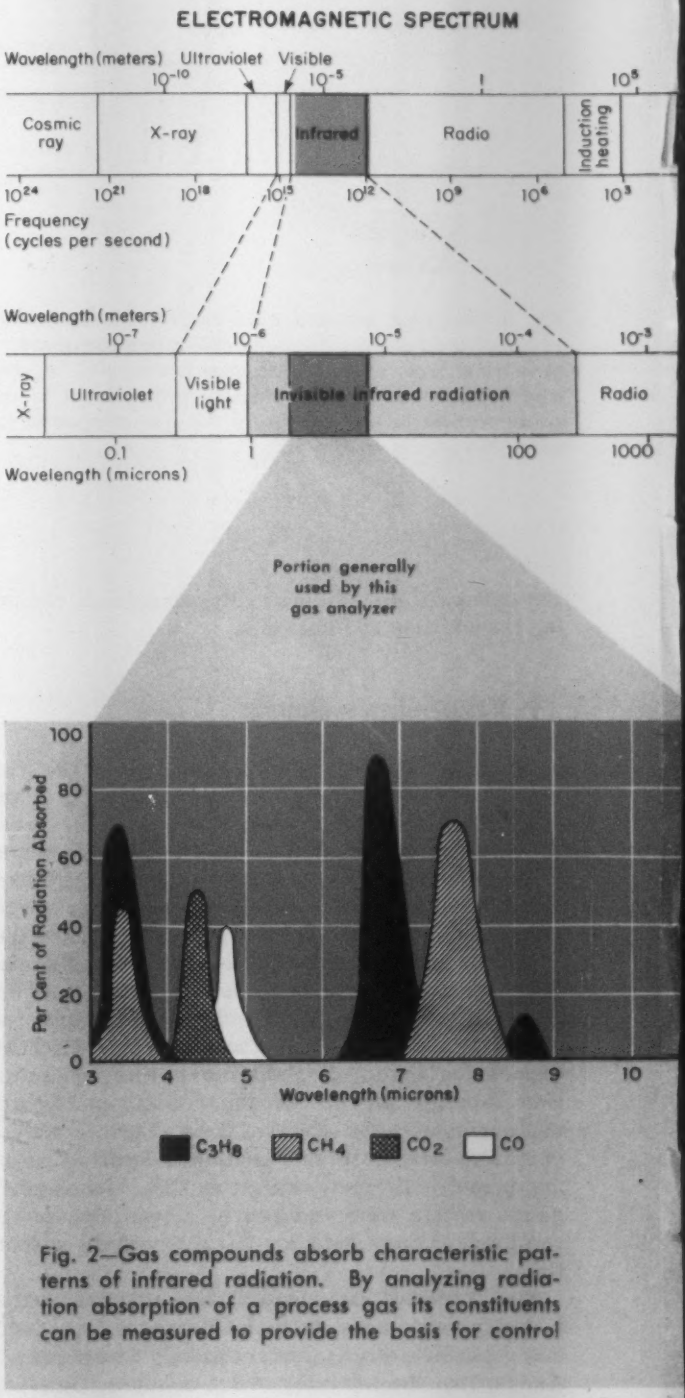


Fig. 2—Gas compounds absorb characteristic patterns of infrared radiation. By analyzing radiation absorption of a process gas its constituents can be measured to provide the basis for control

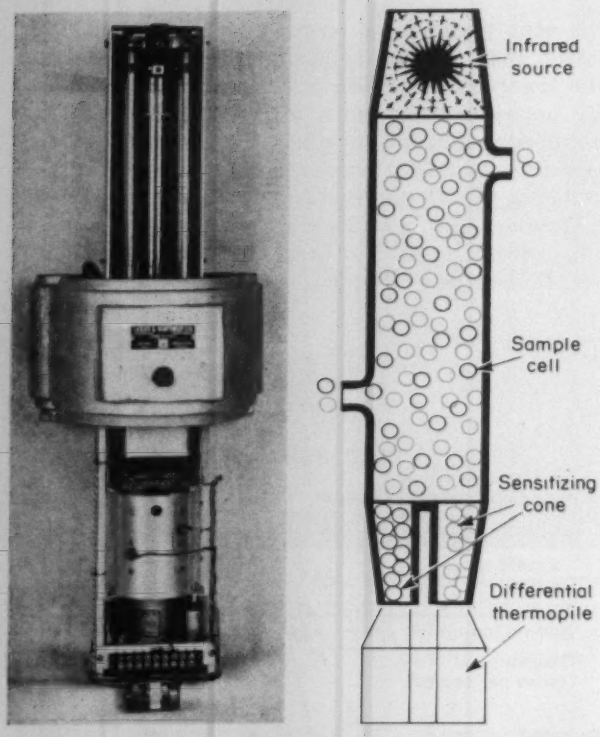


Fig. 3—This type infrared analyzer consists essentially of an infrared source, a sample cell, a two-compartment sensitizing cone, and a differential thermopile. A voltage is obtained which is inversely proportional to the concentration, in the sample, of the gas compound for which the unit is calibrated

are balanced out automatically, sometimes requiring the addition of filter cells.

▶ Result—Fewer Rejects

When the analyzer had been installed in the wire mill it provided a continuous record of CO_2 in the gas as it left the scrubbing tower and the cause of the decarburization was identified. Consistently high readings of CO_2 proved that scrubbing tower and reboiler capacities were not adequate to handle the volumes of atmosphere gas being generated. With the problem thus pinpointed mill personnel cut back somewhat on generator output and increased reboiler heating capacity until the analyzer indicated atmospheres of about 0.05 per cent CO_2 were being obtained. Maintaining this concentration through the aid of the continuous records made available by the analyzer, *Figs.* 4 and 5, operators have been able to reduce decarburization appreciably. In fact, with the CO_2 record as a guide, rejects were reduced to a point where the resultant savings paid for the analyzer in a short time.

The infrared instrument has performed satisfactorily with very little maintenance. An automatic standardizer was originally installed to standardize the analyzer every 8 hours. However, plant operators noticed that such frequent standardization was unnecessary and they switched to hand standardization once a day to economize on calibrating gas. This cycle was subsequently reduced to once a week and then to once a month, a good indication of the stability of the equipment and the cleanliness of the sample flowing through the cell.

This wire mill application of what is usually considered strictly a chemical process tool is not unique. Among several other successful applications of automatic gas analysis techniques to metals finishing operations is that by a large midwestern producer of tin mill strip. Several years ago this company installed analyzing equipment on an exothermic generator producing protective atmosphere for continuous tin plate annealing lines on which strip stock is processed at rates of 800 to 1000 feet per minute. The instruments there have performed satisfactorily even though operation has been almost continuous and of long duration.

These applications and other adaptations of the tools of one industry to the needs of another are highlighting a broad but significant aspect of the trend toward industrial automation—the cross-dissemination of automatic techniques and know-how among all industries.

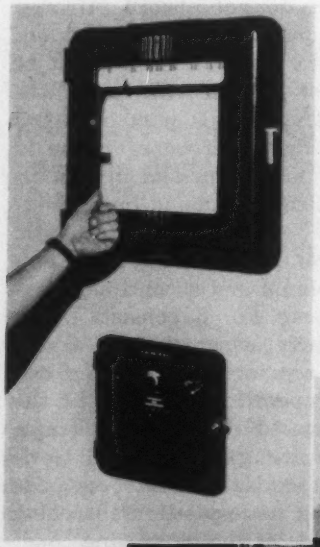


Fig. 4 — Recorder calibrated to read CO_2 content from 0 to 2.0 per cent helped in this wire mill installation to materially reduce rejects due to decarburization

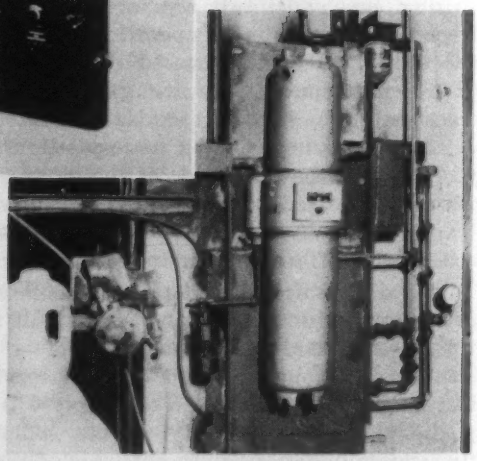
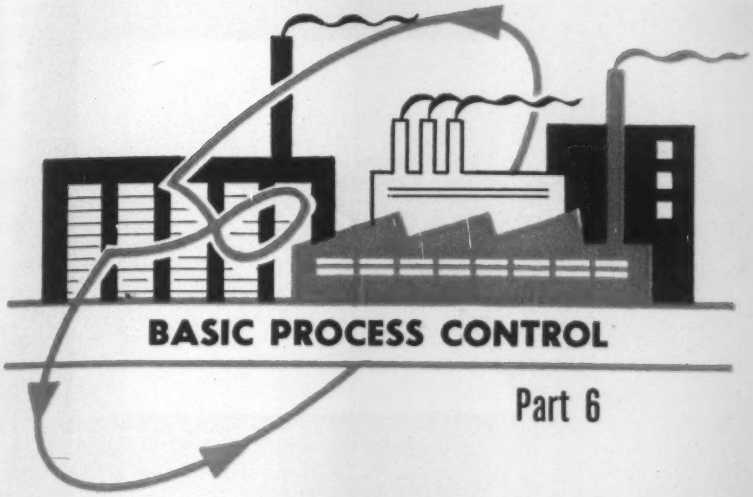


Fig. 5—Analysis of gas reported by the recorder, *Fig.* 4, is made by this infrared gas analyzer through which a sample of the gas is passed



Part 6

SYSTEM ANALYSIS

HOW TO TIE SYSTEM ELEMENTS TOGETHER

By C. W. WORLEY
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Interrelationships among control system components can be sharpened by utilizing the block diagram concept and graphical representation. With these tools, effects of load changes or new settings may be predicted with greatly reduced computational effort

SELECTION of control apparatus for any particular application comprises the design of a control system and embraces the various considerations set out in the previous parts of this series. The acceptable quality of control performance depends upon the application and must influence the choice of the type of control to be employed. In all cases, the design and performance of the control system will be largely determined by the plant itself. Accordingly, if the best results are required, the plant must be capable of producing such results when suitably regulated by the controlling unit.

It has been shown that the performance of a control system can be modified by varying the parameters of the control system equation. The relationship between these parameters and the transient performance is usually complicated and the numerical solution of such equations involves a great deal of computation. In an actual plant, manipulation of the equation parameters is effected by adjusting the settings of the controlling unit and, although the nature of the control system equation is seldom known, the performance obtained represents the solution of this equation.

The control engineer, therefore, finds it expedient to abandon the computation of the actual transient curve, in which he is seldom really interested, and to seek a criteria which allows him to quickly evaluate the performance of the system. The method most widely used is based upon an evaluation of the stability of the system through use of the system open-loop frequency characteristics.

Optimum Performance of Systems

Measure of the effectiveness of a process control system is its response to disturbances which

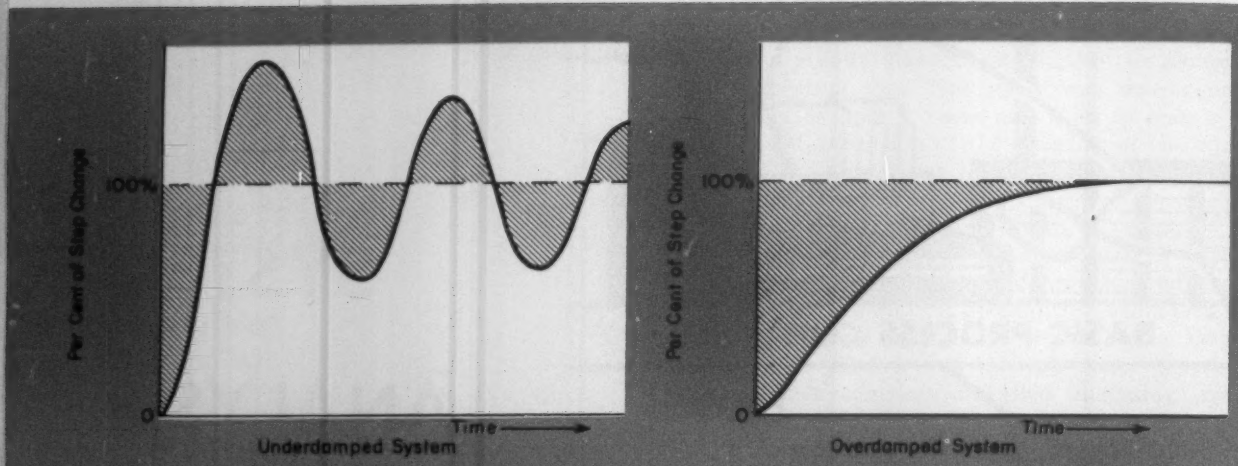

Fig. 1—Control areas for underdamped and overdamped systems. The area enclosed between the response curve and balanced condition indicates both the magnitude of deviation and the time needed for the correction to be applied

affect the operation of the process. These disturbances may be random, such as load disturbances, or they may be deliberate, such as set-point changes. The form and shape of the transient response of the system for a disturbance is a measure of system suitability for control.

In evaluating the performance of a process control system, stability of control is always the foremost consideration. However, the increasingly rigorous demands placed on process control systems are far from satisfied by this single requirement. Usually a completely satisfactory control system must show a behavior that is not only stable but somewhat aperiodic, that is, the transient must die out with time. Aperiodic behavior can be obtained with many combinations of parameter values which, as previously mentioned, complicate the mathematical determination of the system performance.

Acceptability of performance of a control system is affected markedly by two quantities—the largest deviation of the controlled variable from its equilibrium point, and the duration of the response. Both must be minimized in order to obtain optimum response of the system. It is expedient to combine these quantities into one, choosing for this purpose the area enclosed between the curve indicating response to a step disturbance and the line drawn through its rebalanced state. This area can be applied as a measure of the effectiveness of the performance of a control system.

An ideal control system would perform such that for a step change in the set-point or load disturbance the new desired value would be reached immediately with no error. Because of the physical nature of energy transfer this is impossible to achieve. Therefore, in process control the system is designed to give an essentially aperiodic transient response and the area enclosed between the response curve and the final equilibrium level is made a minimum.

Curves of *Fig.* 1 show that the control area depends upon the damping of the system and its speed of response. It can be shown mathematically that a minimum area will be obtained when the ratio of succeeding peaks of the transient response is one-quarter. This type of response is known as one-quarter amplitude response and is illustrated by the curve of *Fig.* 2.

In Part 2 it was pointed out that the degree of damping of a system depends upon the total amount of open-loop phase lag at an open-loop gain of unity. It has been found that one-quarter amplitude response will be obtained for a total open-loop phase shift of -150 degrees at a gain of unity. This is commonly expressed as phase margin which is defined as the difference between the stability limit (-180 degrees) and the actual open-loop phase shift. Thus for one-quarter amplitude response the phase margin is 30 degrees. It follows that for less overshoot of the response, the phase margin should be larger with a correspondingly slower response time. For faster response times, the phase margin should be smaller giving larger overshoots. As a general rule a phase margin of 30 degrees yields an acceptable response for most industrial applications.

As previously mentioned, the amount of overshoot of the first oscillation of the transient response to a large extent determines the area under the recovery curve and thus the controllability of the system. This overshoot is also a function of system damping and depends upon the amount of gain in the control loop. The maximum amount of gain exhibited in the intermediate frequency range of the system frequency-response gain curve indicates the amount of the first overshoot of the transient response. Usual practice in process

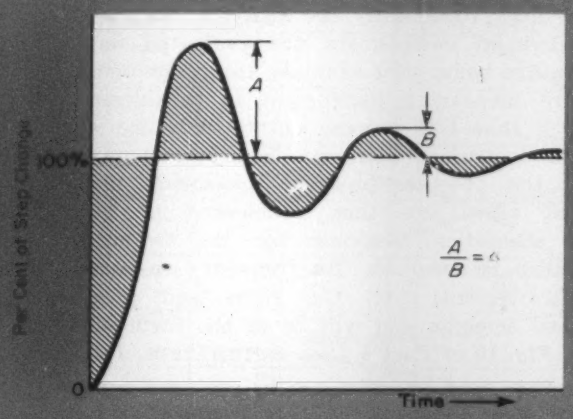

Fig. 2—Control area for one-quarter amplitude response. This system is most desirable because the shaded area is the mathematical minimum

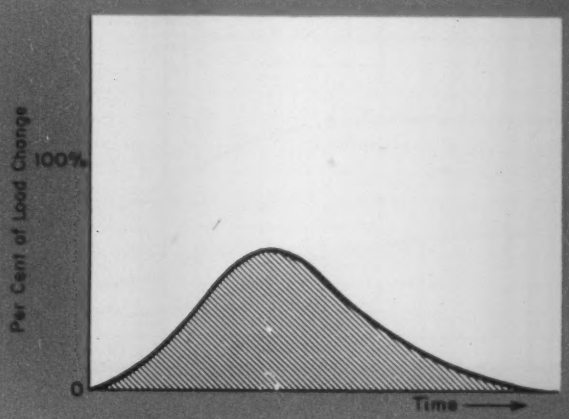

Fig. 3—Typical control area for a load disturbance. The shaded area represents the control area of the response

control design is to limit this maximum gain to approximately +6.0 decibels which yields transient performance with optimum conditions. For this range of maximum gain the peak overshoot of the gain curve is very nearly the same as the amplitude of the first overshoot of the transient for a set-point change.

It is obvious that the response of the system for load changes should be such that the area under the response curve will be a minimum. The transient curve shown in *Fig.* 3 is typical of the system response obtained for a load disturbance. In order to keep the control area to a minimum the system should be relatively insensitive to signals over the frequency range of the system when analyzed as a regulator. Thus the criteria of performance for load changes conflicts in some degree with the requirements for optimum response to set-point changes. As in all engineering design a compromise must made in order to arrive at a suitable control system.

These characteristics may best be illustrated by considering an example of control system design. In addition, it will serve to tie together the material of the previous articles and will illustrate the techniques used in control system design.

▶ Analysis of a Pressure System

The control system to be analyzed will be used to control the output pressure of the pressure process previously analyzed in Part 5 of this series. The response of the system for load disturbances and set-point changes will be determined. The effect of varying the controller gain and reset settings on the system response will also be determined.

Block diagram of the proposed control system is shown in *Fig.* 4. A two-mode industrial-type pneumatic controller will be used to modulate a pneumatic control valve. A pneumatic force-balance type pressure measuring instrument will be used to measure the process output pressure. The output of this instrument is pneumatic pressure which is fed into the deviation chamber of the stack-type controller.

Frequency-response characteristics of the process, pressure measuring instrument, and control

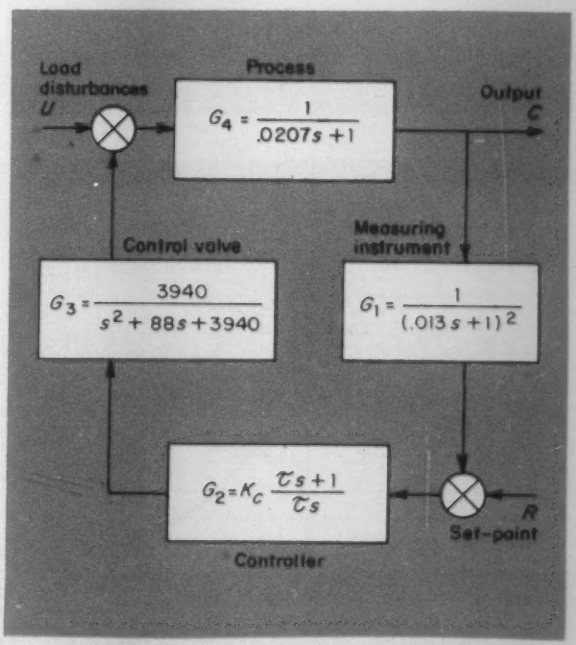

Fig. 4—Block diagram of the pressure control system analyzed in Part 5. Frequency-response characteristics of the elements of this process are shown in *Figs.* 5, 6, and 7

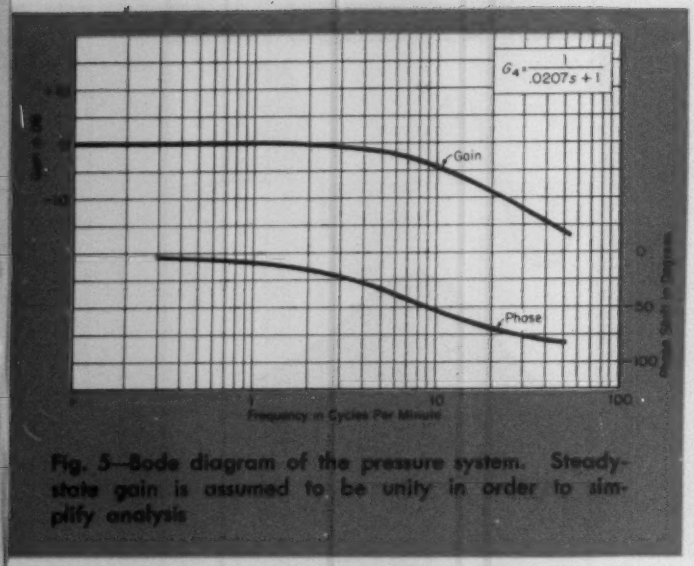

Fig. 5—Bode diagram of the pressure system. Steady-state gain is assumed to be unity in order to simplify analysis

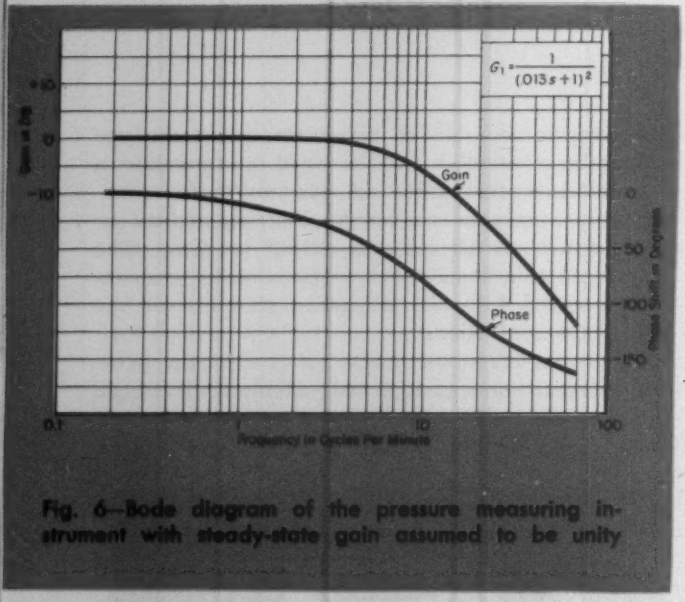

Fig. 6—Bode diagram of the pressure measuring instrument with steady-state gain assumed to be unity

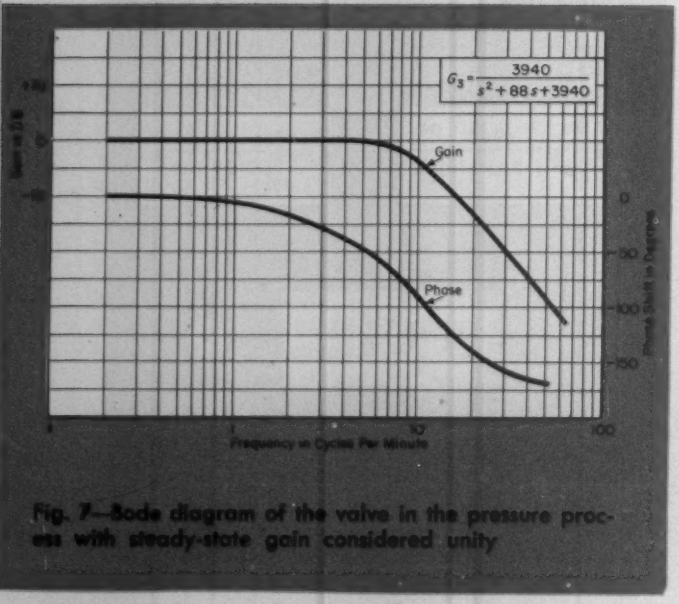

Fig. 7—Bode diagram of the valve in the pressure process with steady-state gain considered unity

valve are shown in *Figs.* 5, 6 and 7, respectively. In order to simplify the analysis, the gain of the individual components are evaluated on a percentage basis. For example, the range of the pressure measuring instrument is considered to be such that full process output pressure will give full instrument output. The steady-state gains of the process, pressure measuring instrument and valve are then considered to be unity. A theoretical response for the two-mode controller is assumed. Its frequency response curve will depend upon the reset and proportional band settings and will be of the form illustrated in *Fig.* 10 of Part 4 (See AUTOMATION, July 1955).

First step in analyzing the proposed control system is to total the gain (in decibels) and add the phase curves for the valve, process, and measuring element. The resulting curve is shown in *Fig.* 8 as a plot of $G_1 + G_3 + G_4$. The open-loop frequency response for the system can now be obtained by adding the controller frequency response curves to $G_1 + G_3 + G_4$. However, before the open-loop curve can be drawn, the controller curves must be selected. In order to obtain one-quarter amplitude response the total open-loop phase shift must be -150 degrees. Since the control area is a function of the amplitude and period of the recovery curve, it is desirable to increase the frequency at which the phase lag of 150 degrees occurs. Note that this frequency may be varied by changing the amount of phase lag in the open-loop due to the controller. For a reset rate of 4 repeats per minute the phase lag due to reset action is -5 degrees and a phase margin of 30 degrees occurs at a frequency of 6 cycles per minute. At a reset rate of 70 repeats per minute the phase lag due to reset is -75 degrees and the 30-degree phase margin occurs at a frequency of 2.9 cycles per minute.

The period of the system recovery curve would be smaller if the lower reset rate were used. However, the system damping will be very small giving a large overshoot in the transient response. For this reason a compromise must be made between recovery time and transient overshoot. As a general rule a phase lag due to reset of from 50 to 55 degrees will give optimum response for a set-point change.

The open-loop frequency response phase curve for a reset rate of 44 repeats per minute is shown in *Fig.* 8. The frequency at which the 30-degree phase margin occurs is 3.3 cycles per minute. The controller gain curve for a gain of unity is first added to curve $G_1 + G_3 + G_4$. This curve is then adjusted to give an open-loop gain of unity at a frequency of 3.3 cycles per minute, accomplished by moving the gain curve down—6.0 decibels which means that the controller has a gain of 0.5. Therefore, the open-loop criteria of unity gain for a phase margin of 30 degrees is satisfied by a controller reset rate of 44 repeats per minute and a proportional band of 200 percent.

Next step in the synthesis of the control system is to form the closed-loop frequency response from

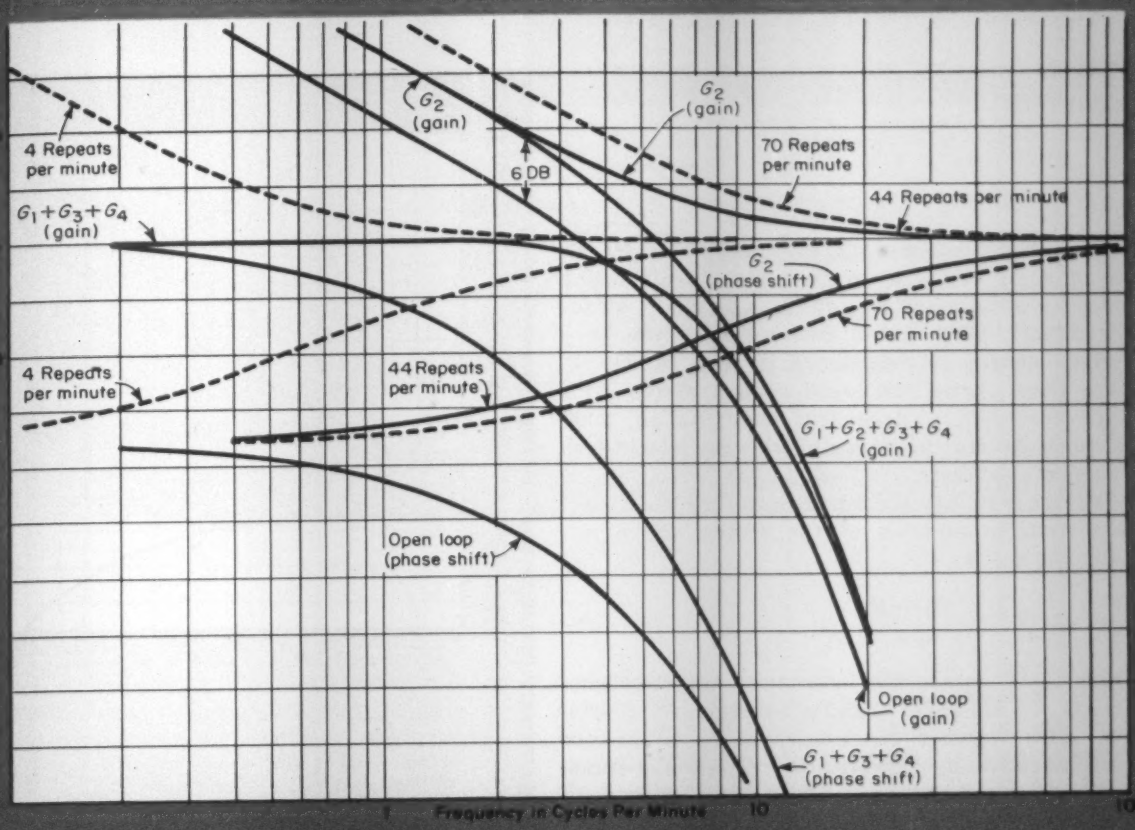

Fig. 8—Open-loop frequency response of pressure control system. Open-loop curves for the system are determined by adding $G_1+G_3+G_4$ curves and the G_2 curves

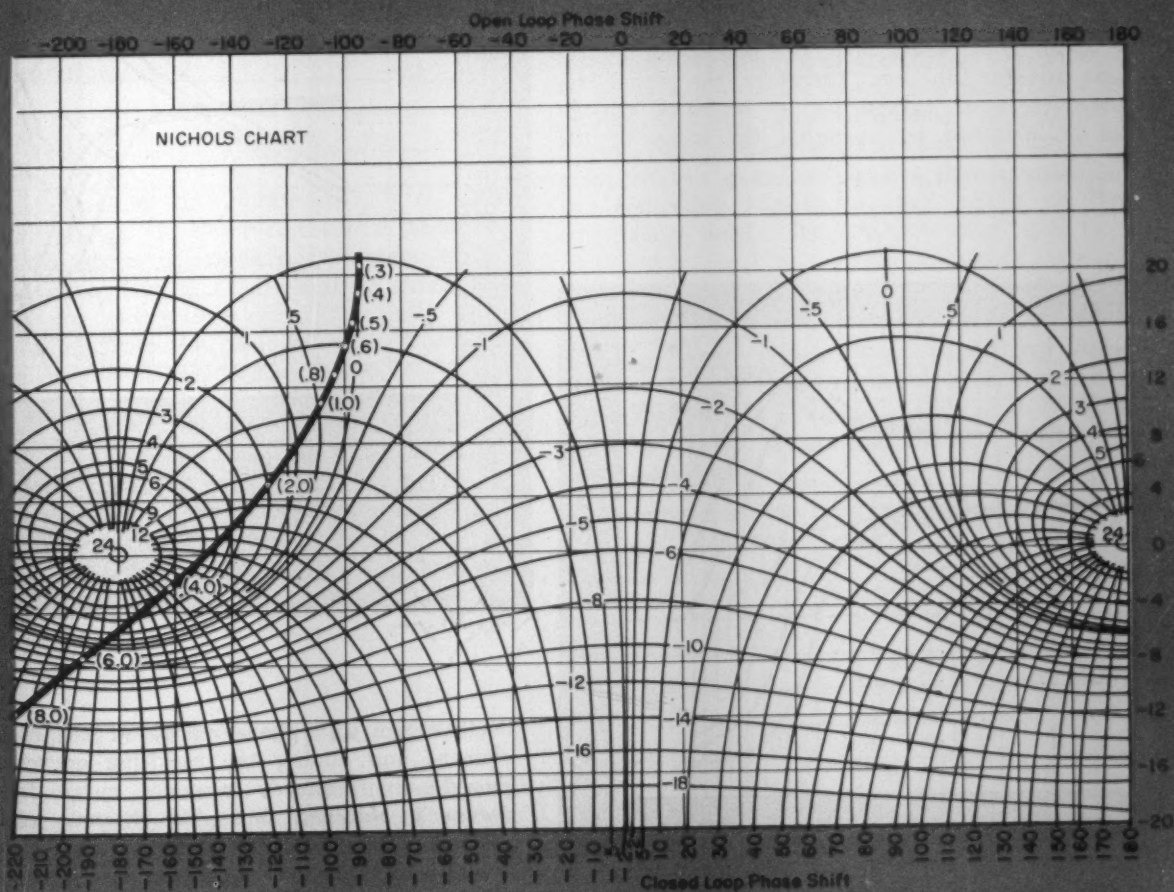

Fig. 9—Nichols chart used to determine the closed-loop frequency response from the open-loop response. Also shown is a plot of open-loop frequency response as a function of frequency in cycles per minute

the open-loop response. This is facilitated by the use of a log modulus versus angle chart showing contours of constant magnitude and phase of the closed-loop. This curve, commonly known as a Nichols chart[1], is reproduced in part in *Fig.* 9. Since these curves are based upon a system with unity feedback, a geometric manipulation must be made in order to obtain the true closed-loop frequency response.

Referring to *Fig.* 4 it can be seen that the closed-loop transfer function of the system for a set-point change is

$$\frac{C}{R}(G) = \frac{G_2 G_3 G_4}{1 + G_1 G_2 G_3 G_4} \qquad (1)$$

where G_1 = measuring instrument transfer function, G_2 = controller transfer function, G_3 = control valve transfer function, and G_4 = process transfer function. However, the closed-loop transfer function of the system assuming unity feedback would be

$$\frac{C}{R}\left(\frac{G}{1+G}\right) = \frac{G_1 G_2 G_3 G_4}{1 + G_1 G_2 G_3 G_4} \qquad (2)$$

Equation 1 can be obtained from Equation 2 by dividing Equation 2 by the measuring instrument transfer function. Therefore, the actual frequency-response curves for a set-point change can be obtained by changing the signs of the decibel gain and phase curves of the measuring element and adding the resulting curves to the closed-loop frequency response curve for unity feedback obtained from the Nichols chart. A plot of the open-loop frequency response as a function of frequency is shown in *Fig.* 9 to illustrate this procedure. The resulting closed-loop frequency response for a set-point change is shown in *Fig.* 10.

[1]References are tabulated at end of article.

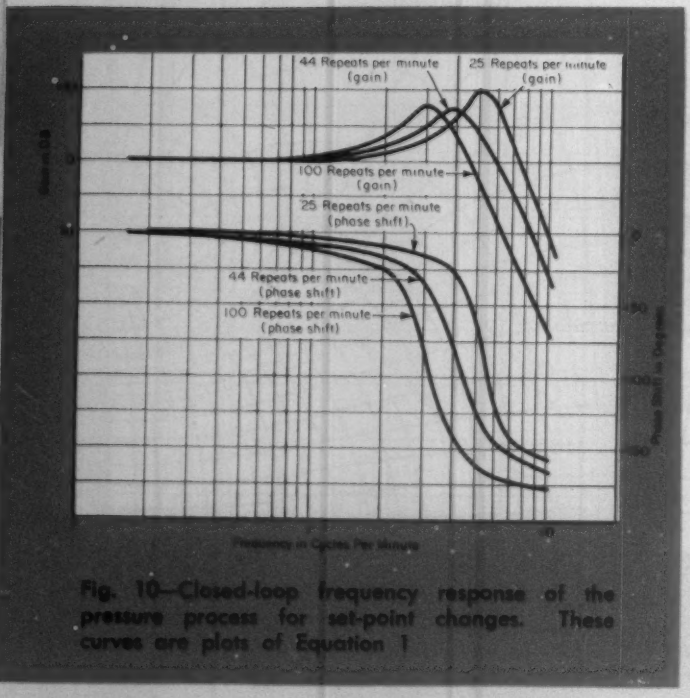
44 Repeats per minute (gain)
25 Repeats per minute (gain)
100 Repeats per minute (gain)
25 Repeats per minute (phase shift)
44 Repeats per minute (phase shift)
100 Repeats per minute (phase shift)
Gain in DB
Phase Shift in Degrees
Frequency in Cycles Per Minute

Fig. 10—Closed-loop frequency response of the pressure process for set-point changes. These curves are plots of Equation 1

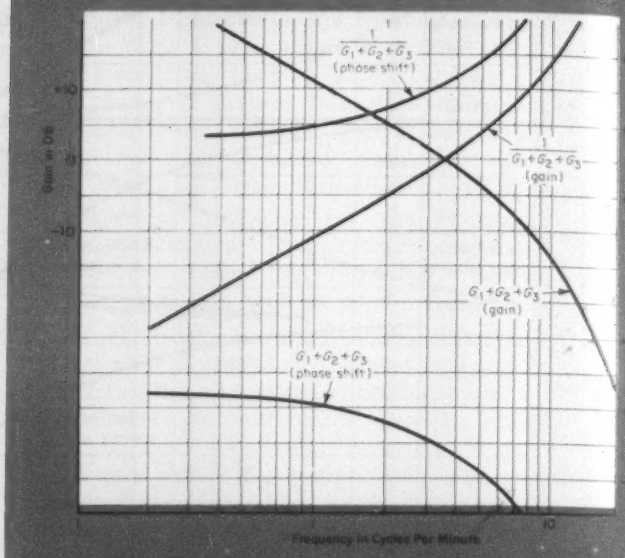

Fig. 11—Frequency response and inverse frequency response of measuring element, controller and valve. Note the symmetry about the zero axis indicating a change in sign

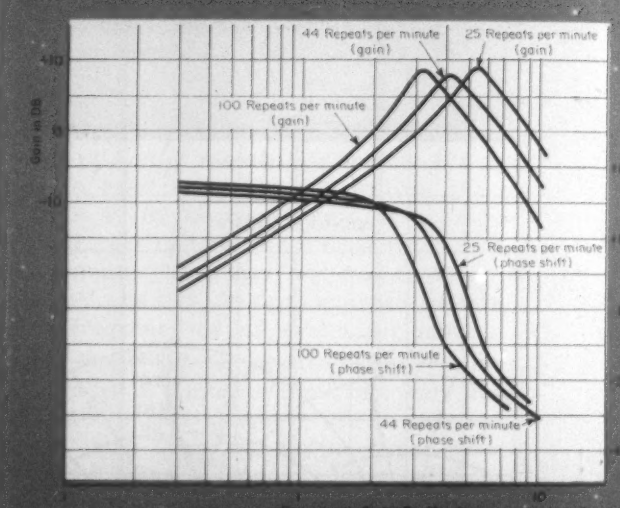
44 Repeats per minute (gain)
25 Repeats per minute (gain)
100 Repeats per minute (gain)
25 Repeats per minute (phase shift)
100 Repeats per minute (phase shift)
44 Repeats per minute (phase shift)
Gain in DB
Phase Shift in Degrees
Frequency in Cycles Per Minute

Fig. 12—Closed-loop frequency response of the pressure control system for load disturbance with three values of reset rate and gain

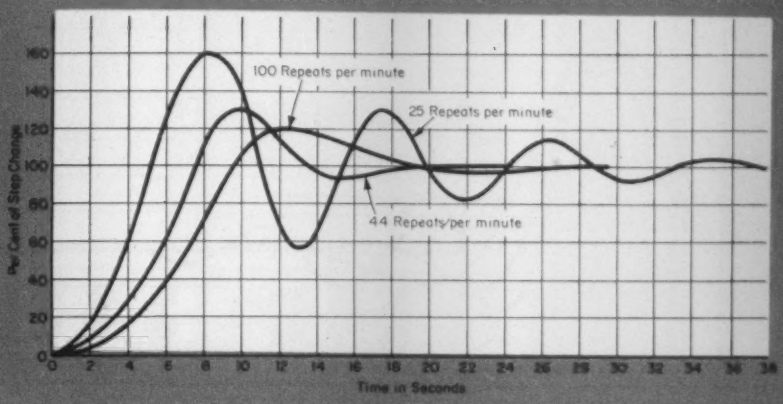

Fig. 13—Transient response of the pressure control system for set-point changes. These curves have been calculated for the various controller settings described previously

Same procedure is used in determining the closed-loop frequency response of the system for a load disturbance. Again from *Fig.* 4 it can be seen that for a load disturbance

$$\frac{C}{U}(G) = \frac{G_4}{1 + G_1 G_2 G_3 G_4} \quad \ldots\ldots (3)$$

The actual system closed-loop transfer function can also be expressed in terms of the system closed-loop transfer function with unity feedback. In terms of Equation 2

$$\frac{C}{U}(G) = \left[\frac{C}{R}\left(\frac{G}{1+G}\right)\right]\left[\frac{1}{G_1 G_2 G_3}\right] \quad \ldots (4)$$

Curves formed by the addition of $G_1 + G_2 + G_3$ are shown in *Fig.* 11. The reciprocals of these are formed, as before, by changing the signs of the gain and phase curves. The resulting curves are added to the closed-loop curve for unity feedback obtained from the Nichols chart. These results are plotted in *Fig.* 12 and this is the closed-loop frequency response for a load disturbance.

In order to show the effect of changing the controller settings on the system transient response, the closed-loop frequency response for both set-point and load changes for three values of reset rate and gain are shown in *Figs.* 10 and 12. Procedures used in obtaining these curves are exactly the same as those used in obtaining the curves for the reset setting of 44 repeats per minute.

▶ Transient from Frequency Response

The control engineer has a choice in evaluating the transient performance of the control system. He may choose to calculate an accurate transient curve from the closed-loop frequency response or he may choose to evaluate certain basic characteristics of the transient curve. In order to illustrate the utility of the techniques available for determining the approximate transient response of the system, the exact transient curves have been calculated for the various controller settings used in the frequency response analysis. These curves are shown in *Figs.* 13 and 14. Techniques[2] used in determining these curves are based upon mathematical manipulations of complex numbers and are beyond the scope of this discussion.

There are, however, methods available for quickly evaluating the transient performance of control systems from the open and closed-loop frequency response characteristics. The methods to be used are based upon an evaluation of the system build-up time originally suggested by Floyd[1]. The system build-up time t_{bu} for a set-point change is defined as the time required for the controlled variable to first reach its final equilibrium level. The approximation used is

$$t_{bu} = \frac{\pi}{\omega_1} \quad \ldots\ldots (5)$$

where ω_1 is the frequency in radians and closed-loop frequency response phase shift is equal to -90 degrees. The build-up time and transient recovery period for each controller setting are tabulated below.

1. Reset = 25 repeats/min
   Gain = 1.0
   t_{bu} = 5.45 sec
   Period = 9.7 sec
2. Reset = 44 repeats/min
   Gain = 0.5
   t_{bu} = 7.0 sec
   Period = 12.0 sec
3. Reset = 100 repeats/min
   Gain = 0.18
   t_{bu} = 9.4 sec
   Period = 15.0 sec

The period of the transient recovery curve is obtained from the open-loop frequency response and is equal to the reciprocal of the frequency at which the open-loop phase shift is equal to -180 degrees. Comparison of these values with the

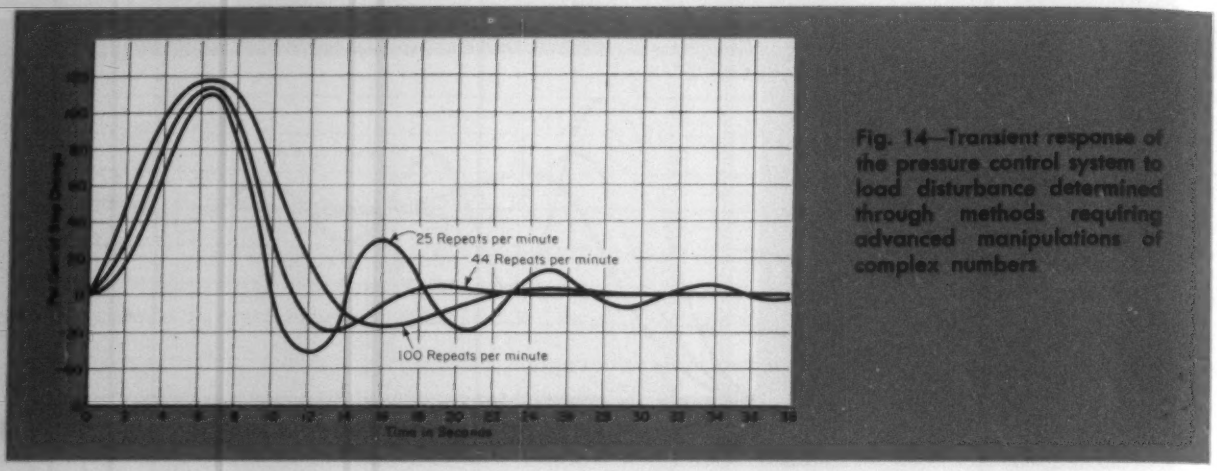

Fig. 14—Transient response of the pressure control system to load disturbance determined through methods requiring advanced manipulations of complex numbers

curves of *Fig.* 13 shows that these approximations agree fairly closely with the actual response of the system. Maximum overshoot of the transient curves may also be quickly determined from standard transient curves[3]. This analysis shows that the approximate transient response of the system can be quickly determined from the system frequency-response curves.

No such approximate methods exist to the authors knowledge, for quickly evaluating transient response of the system for load disturbances. However, the period of oscillation of the transient curve for a load change is the same as that for a set-point change. This will give a good approximation of the response time of the system for load changes and can be used in evaluating different system configurations.

The final article of this series will point out the various uses for feedback control techniques from design of control systems to trouble shooting. With this unified approach, maximum utility of automatic control can be realized through increased understanding of overall problems in control.

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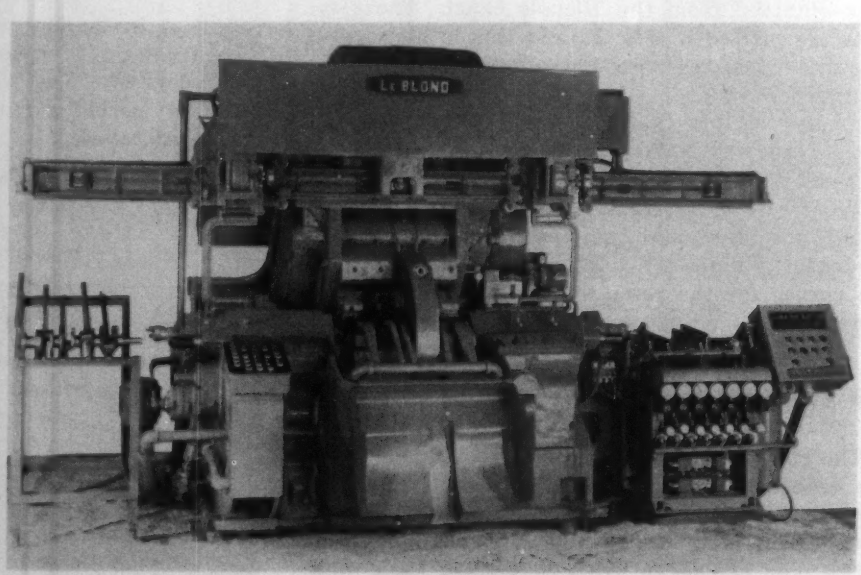
AUTOMATED TURNING

Five main bearings, flange and pilot, sprocket diameter and front end of crankshafts are turned simultaneously on this new automatic machine built by R. K. LeBlond Machine Tool Co. Production rate is about 55 crankshafts per hour. The center drive machine includes arrangment for automatic loading and unloading with hydraulic clamping. Machine motions are sequenced electrically for continuous automatic operation. All operations may be controlled from the master station.



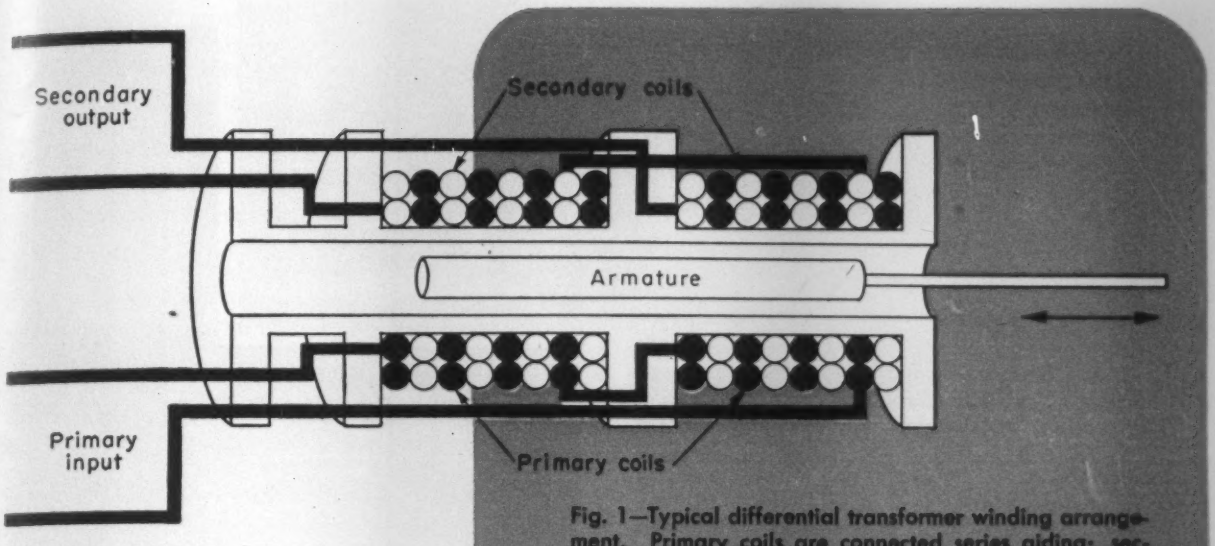


Fig. 1—Typical differential transformer winding arrangement. Primary coils are connected series aiding; secondary coils are connected series bucking. Movable magnetic armature can alter relative flux distribution between primary and two secondary windings which results in a variable output signal

DIFFERENTIAL TRANSFORMERS FOR INDUSTRIAL MEASURING AND CONTROL

By E. G. MURPHY
Market Development Manager
Automatic Temperature Control Co. Inc.
Philadelphia, Pa.

Beginning an automation program does not have to be an "all or nothing" operation. Trial use with investigative tools—such as this servo kit utilizing differential transformers—obviates large risks and provides a background of experience for more detailed application to specific problems

GIVEN a requirement for accurate measurement or control under conditions involving small motions and minute forces with transmission of variables over a distance and you have a natural problem for a servo system built around a differential transformer.

Basically, one of these special type transformers is a transducer which will generate an ac signal which is directly proportional to the position of its armature from the electrical center of the transformer winding. A differential transformer manufactured by the Automatic Temperature Control Co. is shown in *Fig.* 1. This unit consists of two primary coils connected series aiding, two secondary coils connected series bucking, and a movable armature of magnetic material. With ac current supplied to the primary side of the transformer and the movable armature so located that the secondary coils receive an equal magnetic

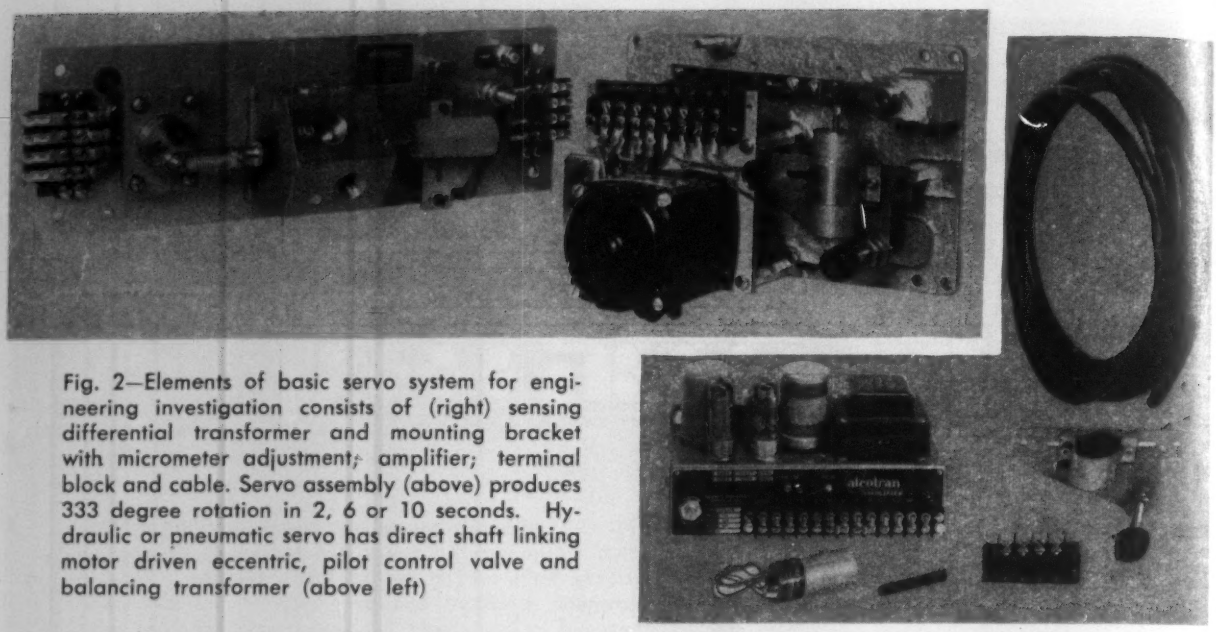
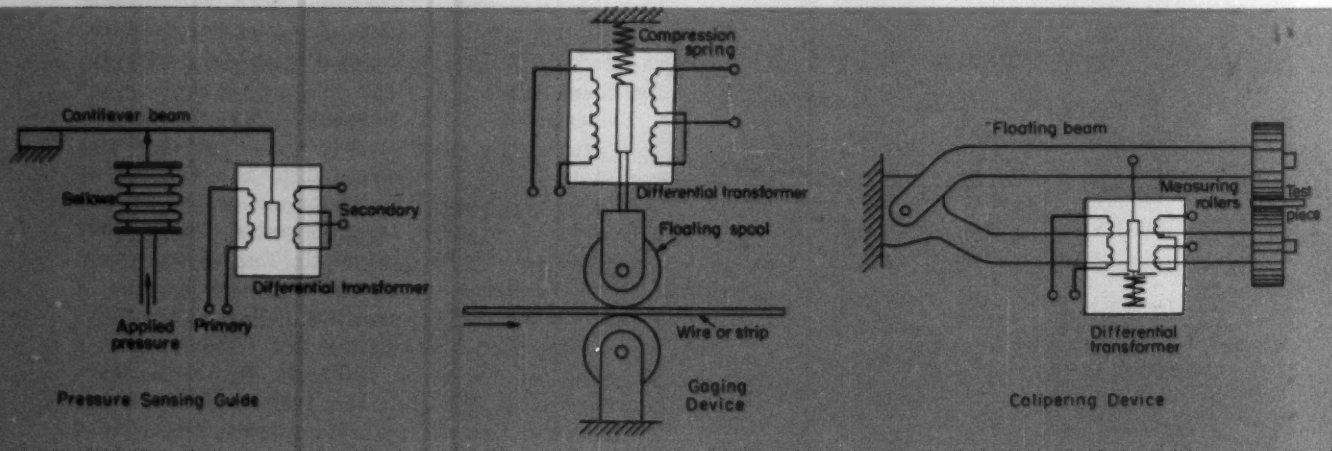


Fig. 2—Elements of basic servo system for engineering investigation consists of (right) sensing differential transformer and mounting bracket with micrometer adjustment; amplifier; terminal block and cable. Servo assembly (above) produces 333 degree rotation in 2, 6 or 10 seconds. Hydraulic or pneumatic servo has direct shaft linking motor driven eccentric, pilot control valve and balancing transformer (above left)

flux—an equal voltage will be induced in each of the secondary coils which because of the series bucking connection will be out of phase and a theoretical output of zero will result at the output side of the transformer. This condition denotes the balance point of the differential transformer. When the armature location is such that one of the secondary coils receives a greater portion of the magnetic flux—then, as mentioned previously, a voltage will be induced which is proportional to the position of the armature.

When connected in proper circuitry with necessary components, this special type transformer becomes an important tool for engineers faced with a measurement or control problem. An appreciation of the versatility of application is contained in the fact that the transformer is available in sizes with an armature displacement of plus or minus 0.01 inch ranging through several sizes to a larger type with armature displacement of plus or minus 2.5 inches. The standard size provides for a movement of plus or minus 0.15 inch.

In anticipating the needs and desires of industrial designers, development and production engineers to experiment with the use of servomechanisms in some applications, the Automatic Temperature Control Co. has developed a complete servo kit containing the essentials for a pilot installation. Normally a problem involving measurement or control would involve the use of two differential transformers in a null-balance circuit and it is with this type of circuit that the kit is furnished. Components of the kit include: Measuring differential transformer and mounting bracket,



servo assembly, amplifier, cable and terminal block, *Fig.* 2. The servo assembly includes the balancing differential transformer connected through a cam actuated lever to a reversible induction motor. This servo unit has a sensitivity of approximately 5000 motor-driven positions with an accuracy of plus or minus 0.025 per cent.

The amplifier contains a transformer which steps down voltage to supply the primary side of the differential transformer and also means of amplifying the output of the secondary side to operate the servo motor. The signal received by the servo motor varies proportionately with the difference in output of the secondary windings of the two differential transformers. If the two transformers, for instance, have the same output due to their respective armatures being in the same relative physical positions within their windings, and hence in the same relative electrical position as regards the amount of flux distribution from their armatures into the secondary windings, the millivoltage output of these two coils, being opposed in phase, 180 degrees, is at null, *Fig.* 3.

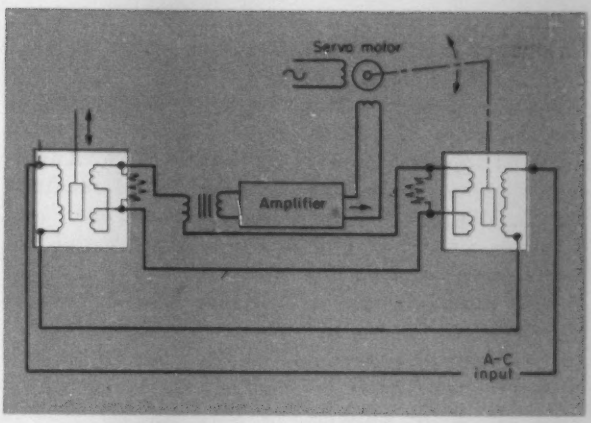


Fig. 3—Standard null type balancing circuit. At balance points, output of sensing transformer and balancing transformer are equal and there is no input to amplifier. Displacing the armature of the sensing transformer will cause a differential output which energizes the servo motor in the proper direction to reposition armature of second transformer to rebalance system

However, if the armature of the measuring transformer becomes displaced, the phase relationship is upset and a millivoltage output difference flows in the circuit. The amplifier detector picks up this output difference, determines the direction of phase change and amplifies the signal which then feeds the reversible induction type motor of the servo assembly. Through gearing, the motor rotates a cam which actuates a lever which in turn moves the balancing differential transformer armature to a new balancing position within its windings. If the upset of the variable being measured were sudden and of a relatively great magnitude, the flow of voltage in the circuit would be a maximum and a strong signal would be fed to the servo motor, causing it to operate at top speed. As the motor driven cam positions the balancing armature nearer to a point at which balance will occur, the differential in output between the two transformers is rapidly but gradually reduced. When the secondary outputs of the two transformers are again equal, the servo motor stops dead-beat without overshoot.

These components can be applied in such a manner that the servo will drive a pen on a recording chart, operate a pointer on an indicator, drive pulleys or cams, position slide wires for electrical controls or contacts, etc. For pilot control of valves and pistons in positioning devices such as in edge control, thickness control, hydraulic presses, work positioning, tool indexing, etc., a hydraulic-pneumatic servo is used. This is a modification of the standard servo with the addition of a hydraulic or pneumatic valve and an eccentric for positioning of the control valve stem. The pilot valve is connected directly to the balancing armature shaft. The null balance type of circuit, as

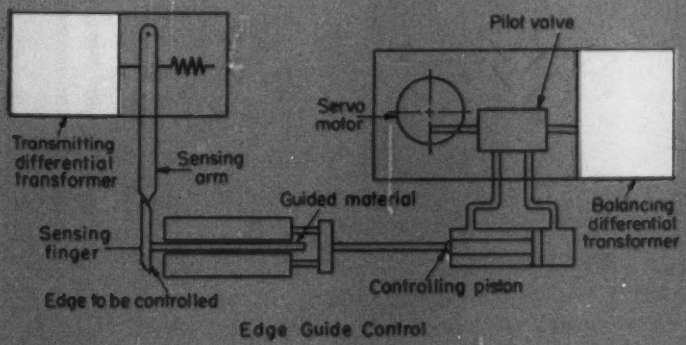
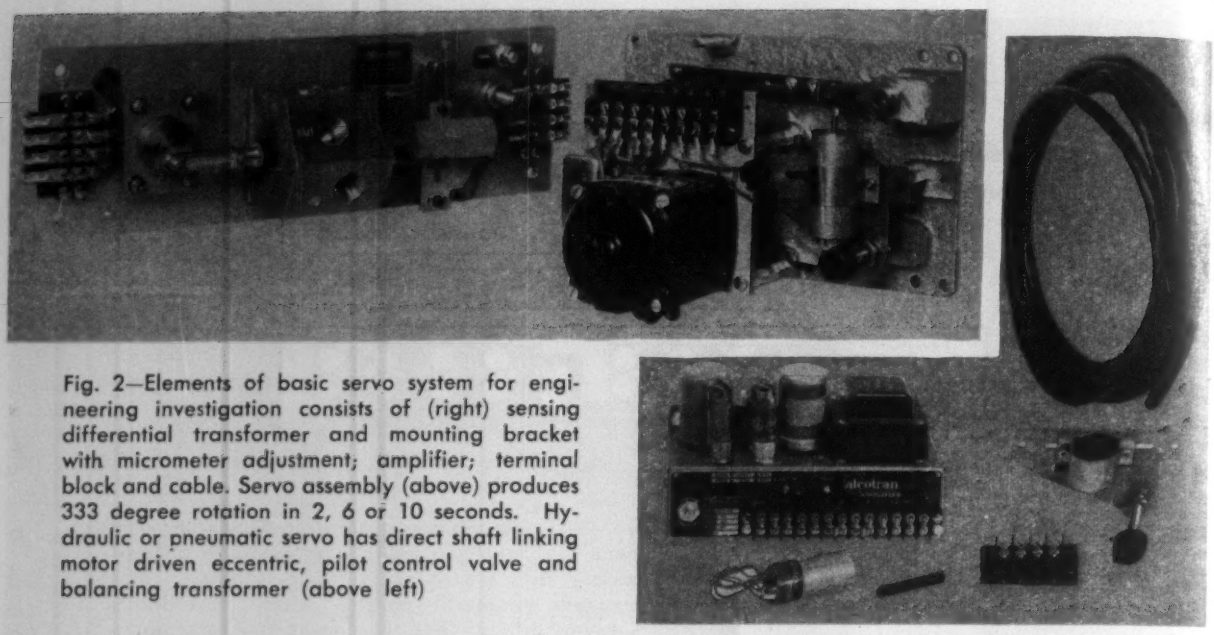


Fig. 4—Examples of sensing devices. The indicated sensing transformer is connected in null type balance circuit which has been previously described. Servo which rebalances system is made to operate indicator, recorder or control at some remote position



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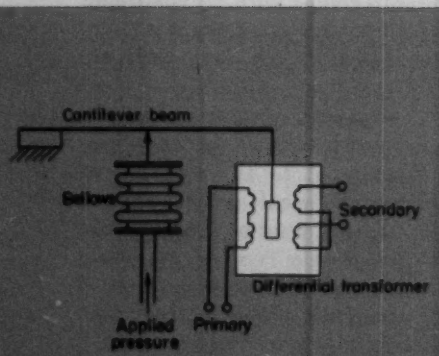
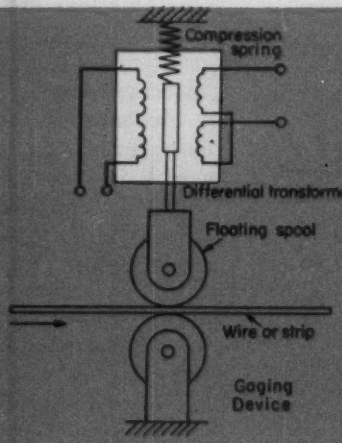
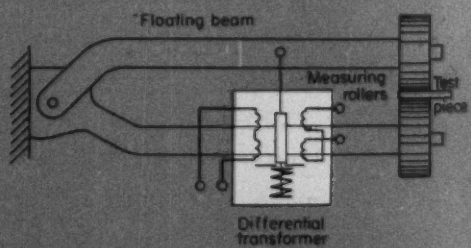


Pressure Sensing Guide





Calipering Device

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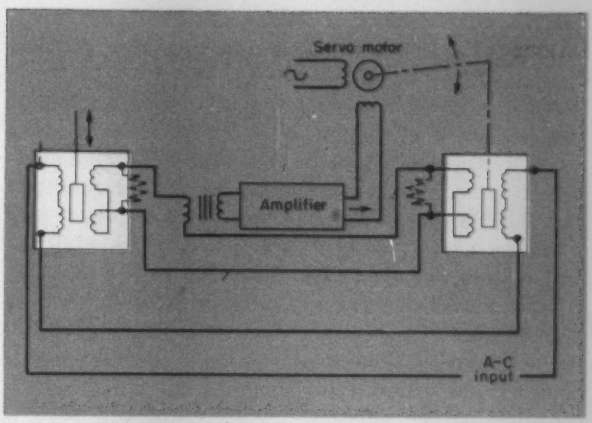

Fig. 3—Standard null type balancing circuit. At balance points, output of sensing transformer and balancing transformer are equal and there is no input to amplifier. Displacing the armature of the sensing transformer will cause a differential output which energizes the servo motor in the proper direction to reposition armature of second transformer to rebalance system

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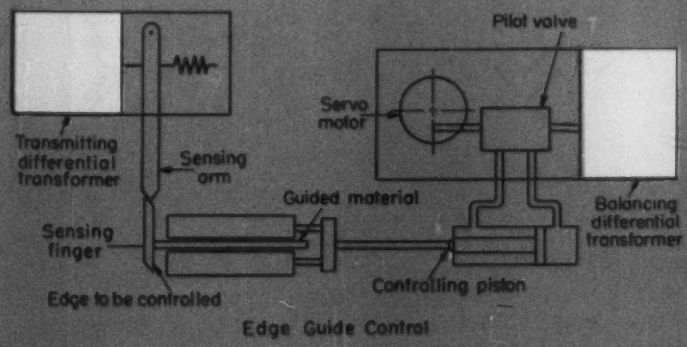


Fig. 4—Examples of sensing devices. The indicated sensing transformer is connected in null type balance circuit which has been previously described. Servo which rebalances system is made to operate indicator, recorder or control at some remote position

described previously, is used. Schematic representations of some differential transformer sensing devices are shown in *Fig.* 4.

An operation involving the automatic gaging of the thickness of plastic sheets illustrates a more involved application of the transducer in which analogous sensings are translated to digital readings *Fig.* 5. To detach from an overhead conveyor and measure a sheet of plastic one inch thick and five feet square required two men prior to the installation of automatic gaging. It was possible only to sample check the total production as each sheet had to be gaged at several points along each edge and across the middle—a job requiring three to five minutes. With the automatic system 100 per cent of production is checked. Plastic sheets hanging vertically from an overhead conveyor are passed through a calipering stand consisting of guides to steady the sheet and six measuring calipers. Each of the six calipers has three differential transformers —two transformers sense thickness and one transformer compensates for skew. Each sheet is gaged at six-inch intervals across the sheet length and then readings are automatically registered on a digital printer for record purposes. Each measuring circuit contains a separate servo system. In the individual system, each servo follows the measurement displacement of the thickness calipers and when a signal calls on the print circuit to operate, the servos all lock in position; the digital converter circuit closes from the sensing contacts which indicate the shaft position of each of the six servos in the loop (one servo for each set of three sensing transformers). When all contacts are closed in a series-connected arrangement for each of the digital converters, a time delay of 0.05 second starts for the purpose of allowing contact bounce in the digital converter fingers to settle out. Termination of this delay causes a 0.025 second pulse to feed into the automatic printers to align their printing wheels and initiate the print signal. The servo circuit then opens and the servos are unlocked and are then ready to act on a new signal. The entire measuring cycle takes but one-half second.

The servos used in the more complex application are basically the same as the ones in the less complex illustrations—all make use of the simple reversible induction motor positioned shaft and cam with balancing differential transformer feeding a circuit containing the second measuring transformer. This basic simplicity has resulted in the development of a complete line of ATC indicating, recording and controlling instruments for many devices and mediums such as force, motion, level torque, tension, thickness, edge positioning and gaging; the application of the servo kit to the investigation of certain industrial problems is limited apparently only by the imagination of the user.

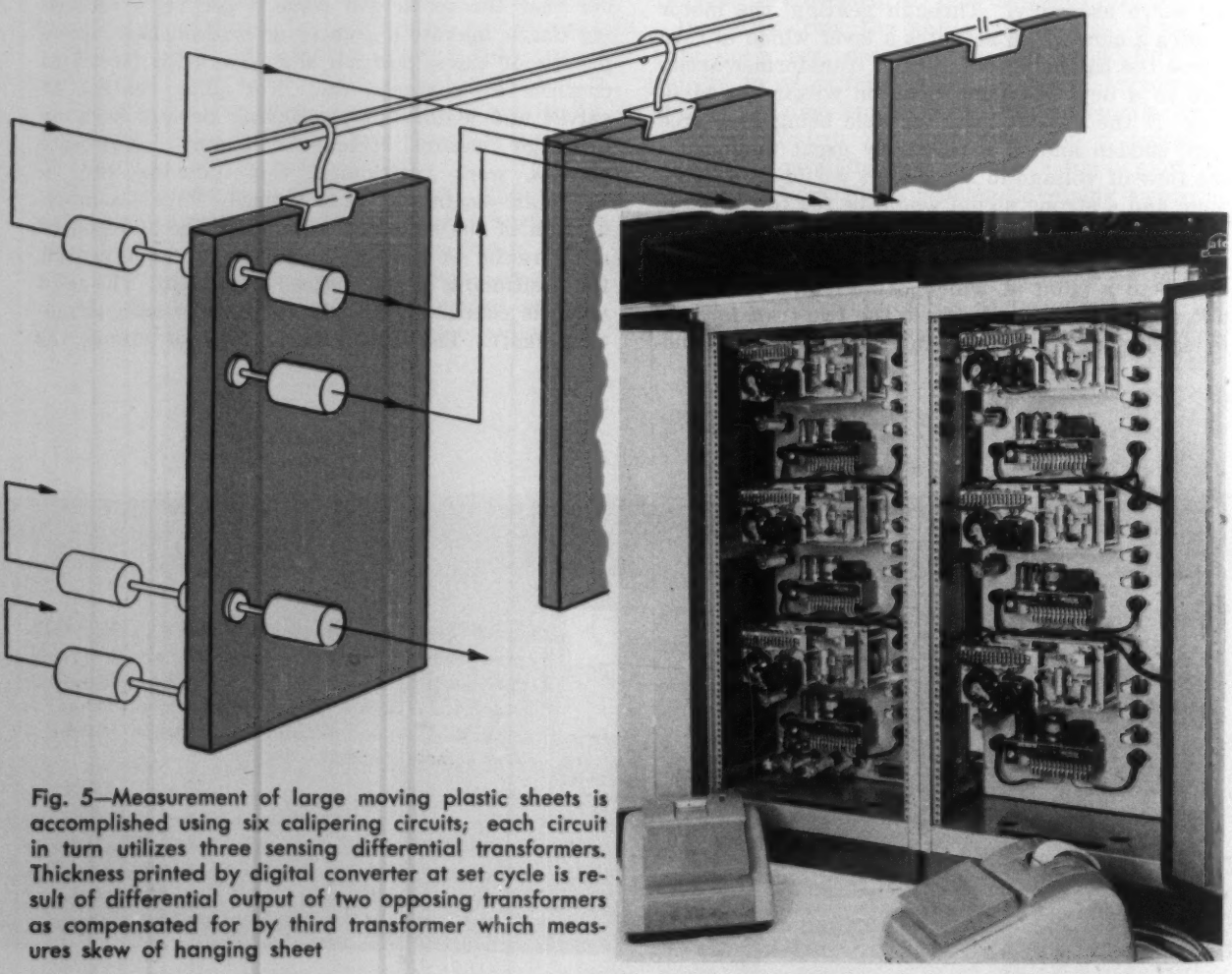


Fig. 5—Measurement of large moving plastic sheets is accomplished using six calipering circuits; each circuit in turn utilizes three sensing differential transformers. Thickness printed by digital converter at set cycle is result of differential output of two opposing transformers as compensated for by third transformer which measures skew of hanging sheet

Fig. 1—Automatic boring machine is governed by the tape control equipment at left. Cutting tools are being adjusted by man in center, and a control tape is being prepared on the punching unit at right

BORING UNIT . . . . TAPE CONTROLLED

Workpiece carried on a rotary fixture mounted on the cross slide of a precision boring machine is automatically bored with positional accuracy of plus or minus 0.0005-inch. The machine, controlled by punched tape, is considered suited for medium size production lots

DESIGNED FOR BORING shaft holes in gear plates where the center-to-center tolerances must be tight to prevent binding or backlash, an adaptation of a precision boring machine for automatic operation has been made with a punched-tape control. The system worked out by Minneapolis-Honeywell Regulator Co. uses a standard 4-spindle Excello precision boring machine with special cross slide and workpiece fixtures; modified controls and circuitry; and a tape reader housed in a supplementary control cabinet.

Gear plates to be bored are held in a rotary fixture by an adapter ring. This fixture rotates the workpiece about an axis parallel to those of the machine spindles. The rotary fixture is carried by the cross slide which has a linear horizontal motion at right angles to the axes of the spindles. The rotary fixture is positioned by an electric motor, and the cross slide by a hydraulic cylinder. Individual potentiometers on the fixture and the cross slide modify reference voltages to give feedback voltages which indicate the linear and rotary positions occupied.

Somewhat like standard teletype tape, a 5-hole plastic tape is used to control the equipment. Operating instructions are punched on the tape by a perforating machine similar to a typewriter. The punched tape is fed through a tape reader which gives the machine co-ordinate voltage commands corresponding to increments of 0.0001-inch over the 8-inch linear range of the cross slide and 0.01-degree over the 360-degree range of the rotary fixture.

To set up the automatic operation, the proper adapter is used to mount the workpiece in the rotary fixture, needed cutting tools are mounted in the spindles, hole co-ordinates and cycling instructions are calculated and punched into the tape, and the tape is placed in the reader.

After inserting a blank piece in the fixture, the operator merely presses a button to initiate the automatic cycle. Combinations of holes in the tape are translated into command voltages corresponding to desired positions of the cross slide and the rotary fixture. Feedback voltages corresponding to actual positions are compared to

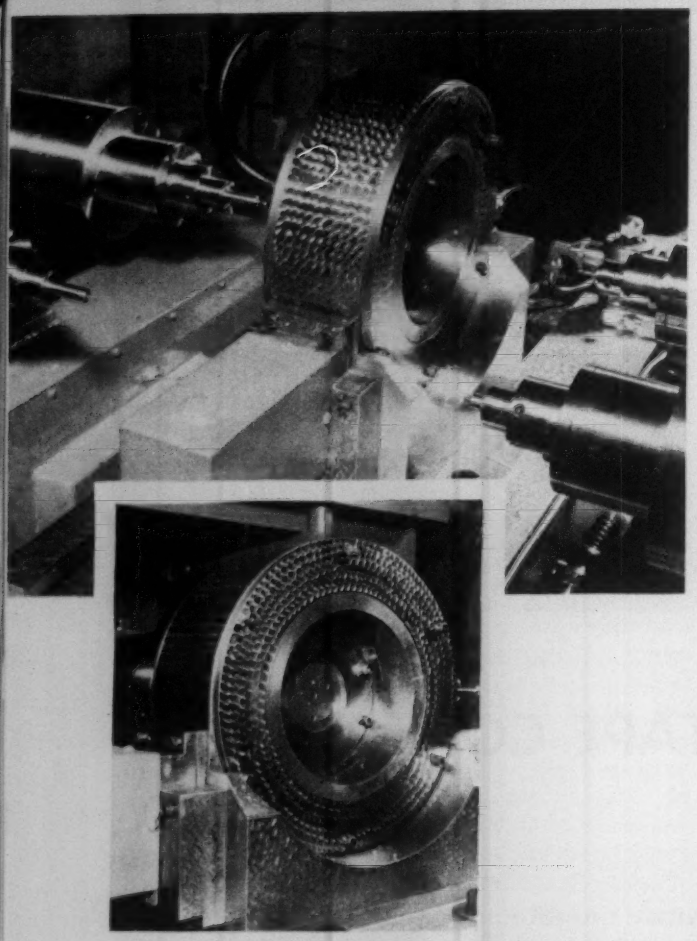


Fig. 2—Rotary fixture carrying the workpiece is mounted on a hydraulically actuated cross slide which positions the piece horizontally in increments of 0.0001-inch over its 8-inch linear range. Workpiece, shown here with holes of various sizes, is held in the rotary fixture by an adapter plate. Rotary movement of the fixture is adjusted in increments of 0.01 degrees over the 360-degree rotary range

the command voltages and the cross slide and rotary fixture are moved until the voltages balance. After the part is positioned (in elapsed time of about 5 seconds per hole) the basic machine feed cycle is started. This feed cycle of the machine itself was not changed, and takes place as directed by the basic machine controls. After completion of a feed cycle, the tape controlled system positions the part to bore the next hole. After the machine has finished all operations called for on the tape, it is automatically stopped to permit removal of the finished part.

Accuracy of the tape-controlled boring machine is better than plus or minus 0.0005-inch. Tape preparation requires approximately five minutes per hole and complete changeover from one part design to another can be accomplished in about 30 minutes. Changeovers merely require changing adapter rings and tooling and inserting the appropriate tape. Where a small number of special plates is needed, the machine can be manually operated by adjusting knobs to control linear travel of the cross slide and rotary motion of the holding fixture.

John Rudolf, head of Minneapolis-Honeywell's automation section says, "Early studies indicate that it (the tape controlled boring machine) is ideally suited for medium-sized production lots (about 500 parts). Tooling and set-up costs are substantially lower than for punch press piercing dies or drill-ream jigs, and operating costs are less than for jig borers."

This system was originally designed and built on an experimental basis for production of gear plates used in aircraft indicators. Studies are now being made to determine its suitability for similar work in the production of precision gyro parts, servomotors and other equipment.

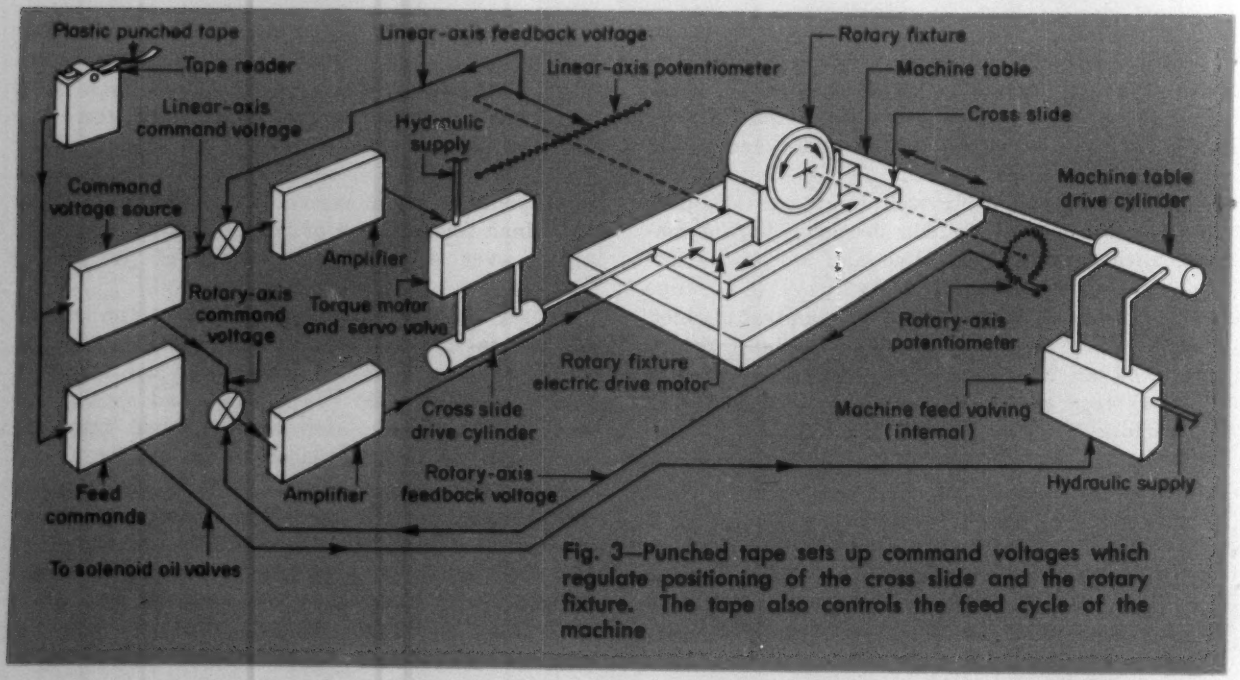


Fig. 3—Punched tape sets up command voltages which regulate positioning of the cross slide and the rotary fixture. The tape also controls the feed cycle of the machine

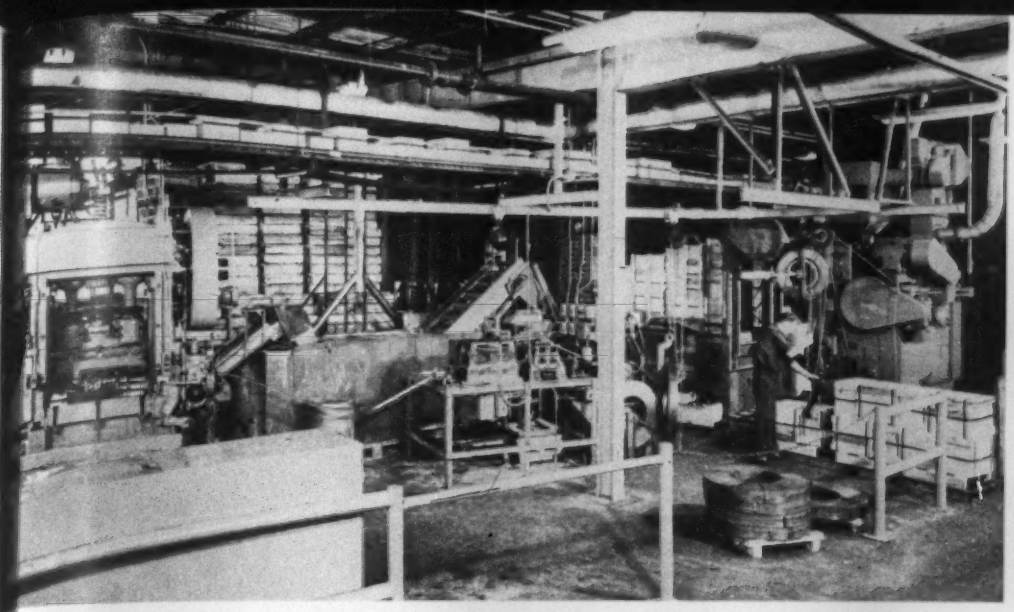


Fig. 1—Complete line for manufacturing stampings at Signode Steel Strapping Co. includes, left to right, 100-ton Bliss punch press, first conveyor, deoiling tank, second conveyor, drying conveyor, accumulator pan, and Wheelabrator shot blast with loader. Stock feeder-straightener can be seen just in front of the deoiling tank

Fig. 2—Close-up of the end of the manufacturing line. Wheelabrator shot blasting machine unloads into shipping box, operator moves box to right, puts cover on, and straps it

STAMPING LINE AUTOMATED

FROM COIL TO PACKAGE

EMPLOYMENT of automatic devices and conveyors makes it possible to automate standard equipment to a surprising degree. Signode Steel Strapping Co. uses one man to attend an entire manufacturing line which can produce six different types of stamped steel plates used by shippers to secure steel strapping to walls and floors of freight cars. Operations in the line include stamping, counting, deoiling, blast cleaning, and packaging.

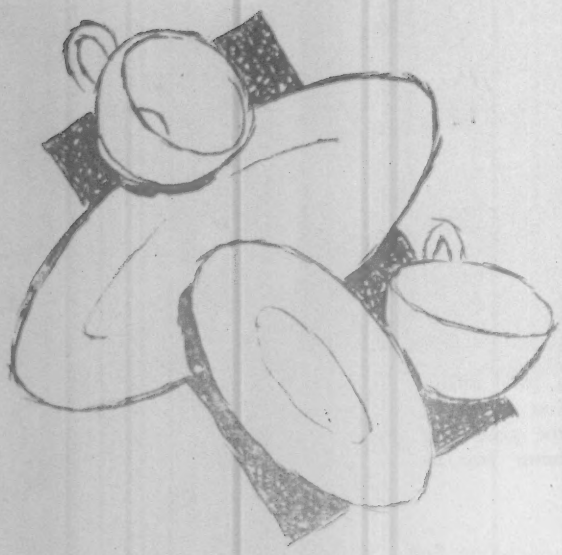
Coiled strip 6 inches wide, 0.125-inch thick, passes through an automatic 100-ton Bliss press for blanking and forming. Formed plates drop onto a conveyor that carries them to the deoiling tank. Detergent solution in the tank is mechanically agitated and kept near boiling point by thermostatically controlled gas burners. A second conveyor carries the washed pieces out of the tank to a third conveyor where they drain and dry of their own heat. Then they drop into an accumulator pan.

Next step in the process is automatic shot blasting in an American Wheelabrator & Equipment Corp. tumble-blast unit which removes burrs left around the edges and holes of the pieces, dulls sharp edges, and provides a satin-matte finish. All but one of the designs of stampings are blasted in loads of 500 pieces; that one style is blasted in loads of 1000.

This is possible because each stamping is counted by a mechanism on the punch press. The press stops for 30 seconds after each group of 500 pieces but conveyors keep moving, and a timer on the accumulator pan follows through to keep the quantities separate once they are counted by the press. The pan automatically drops each set of 500 pieces into a bucket loader for the shot blaster. Operator controls loader electrically.

Once the blasting machine is loaded, attention is not required by the operator. Four minutes of blast with steel shot takes care of deburring on any one of the different parts. Since the unit employs a tumbling action in conjunction with the blasting, all areas of all parts receive the same amount of deburring action.

When a timer signals the operator, he unloads the machine by pushbutton, parts falling into a shipping box. While one lot of stampings is in the machine being blasted, the operator has time to cover the previously filled box and strap it. A completely loaded box comes off the line every 6 minutes.



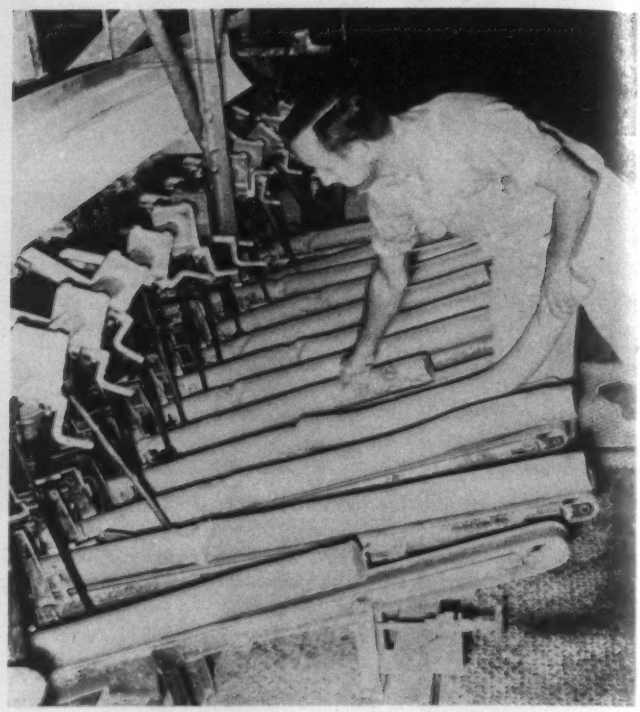
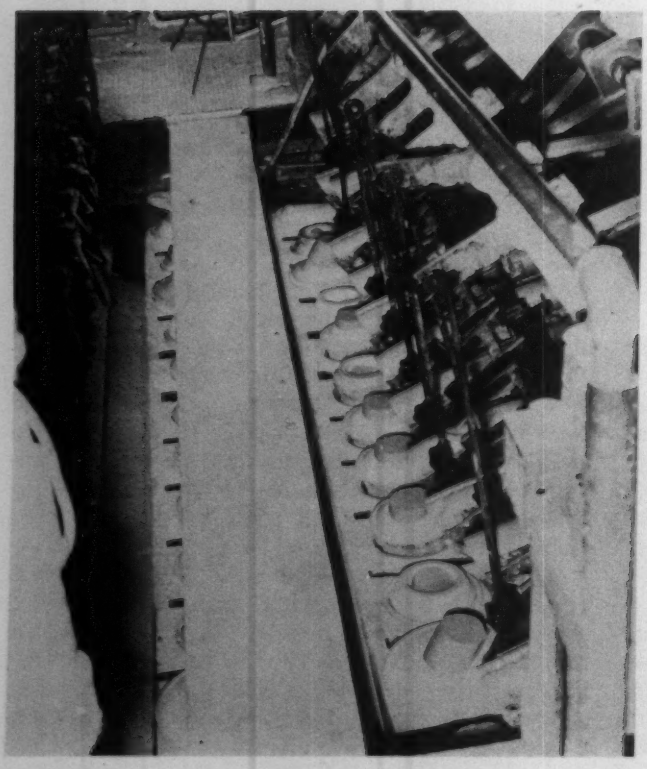


Fig. 1—Prepared clay is fed to this automatic jiggering machine along 12 feeding chutes

DOWNTIME REDUCED AS—

CARBIDES SHAPE POTTERY



Producing pottery shapes automatically, jiggering machine in this pottery plant uses carbide tools. Another example of the use of successful developments in one industry to improve operations in a different industry

Fig. 2 — Predetermined quantities of clay are sliced off and drop into 12 molds which are positioned by an under-floor conveyor

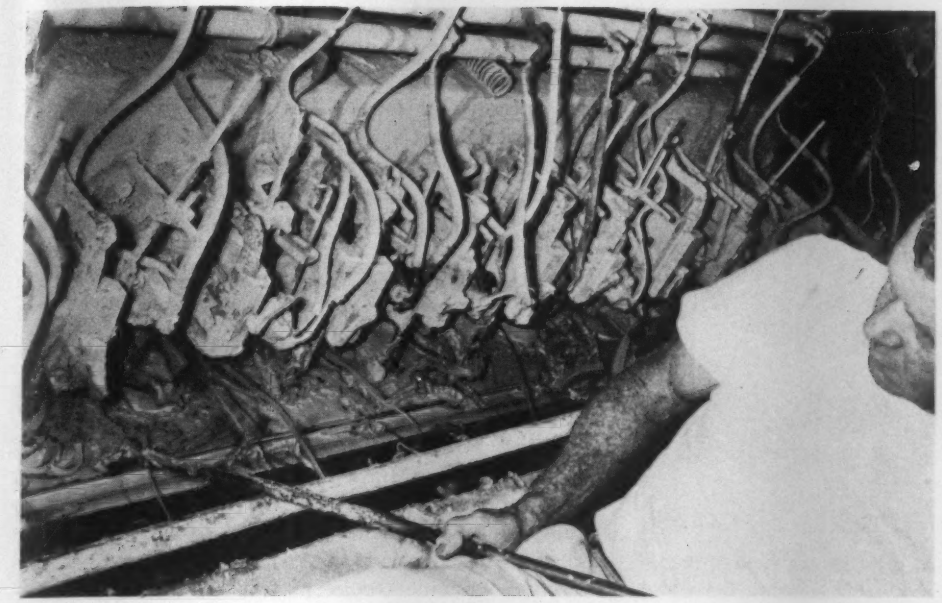


Fig. 3 — Molds are transferred to the jiggering end of the machine where the ware is shaped. Shaping is done automatically with carbide tools. This worker fishes trimmings out from around the molds and knives

ONE LOOK AROUND the plant of Scio Pottery Co. brings home the meaning of mass production. Everywhere you look, there are miles of chain conveyors in "ferris-wheel" action overhead and near floor level; giant room-size merry-go-round production tables for forming molds and speeding ware through glazing; and belt transfer lines and monorails shuttling ware from one processing point to another.

Important in all this automated activity are cemented carbide tools, manufactured with the same materials and process of powder metallurgy as those used for machining operations in metalworking plants. To Scio, these tools have meant high volume production, higher productivity per man-hour, and ability to stay in the dime-store ware business, in spite of higher costs of labor, materials and other services.

A single, 12-station automated jiggering machine, for example, produces 15 dozen pieces of ware or 180 individual pieces per minute. The ware comes through jiggering; and 12 pieces, both flat and hollow, go onto the conveyor line to overhead storage and further finishing each time the machine makes a quick "put-put" noise. An observer can see one man busily loading the machine with sausage-like clay shapes about 3 feet long and 3 inches in diameter, *Fig.* 1; molds being fed to the underside of the machine; predetermined quantities of clay being deposited on the molds, *Fig.* 2; and another operator riding back and forth on a dolly truck, fishing clay trimmings out from around the molds and carbide knives, *Fig.* 3. The cemented carbide tools that enable the machine to operate at such a pace 24 hours per day cannot be seen, being hidden by clay and overhanging machine parts. Yet, 12 sets of them are there, forming an important part of the jiggering operation.

In operation, the action of the tools is just the reverse of that of a cutting tool used in machining metals. The clay is shaped in a "smearing" type action, rather than a cutting action. In this jiggering machine, the tools work fast, and pro-

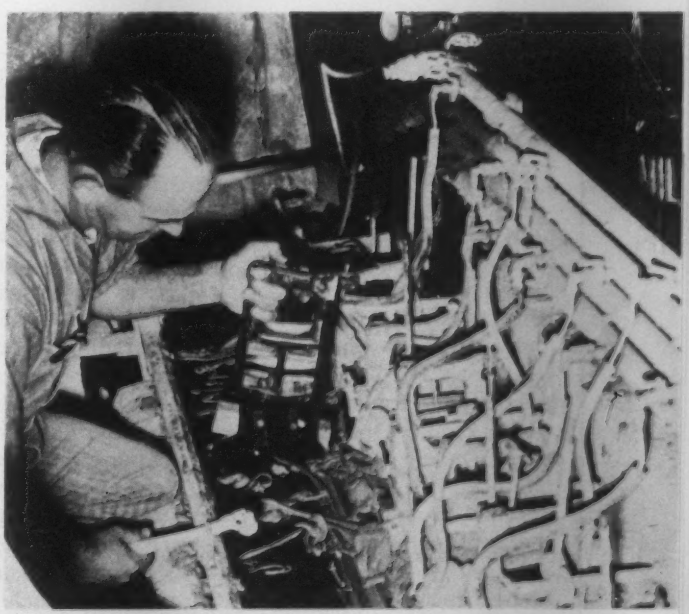


Fig. 4—Knife changing on the automatic jiggering machine means a loss of production of several dozen pieces of ware. Tool life between regrinds increased from eight hours to three to eight weeks when carbide tools were installed

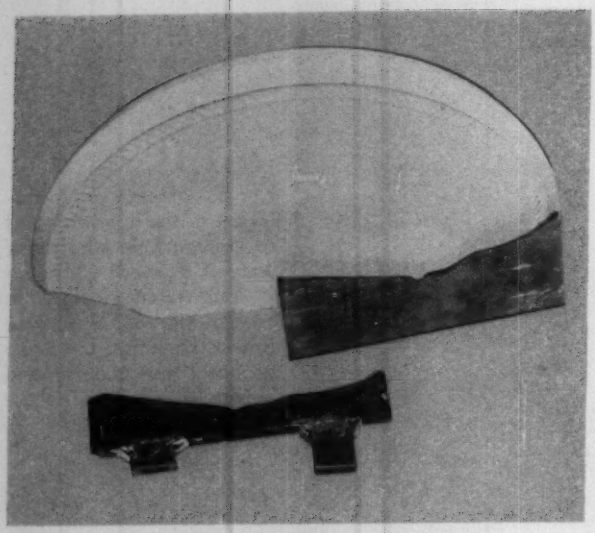


Fig. 5—Solid carbide knife at right shows typical shape and size of new tool. Knife at left is same type tool after 4 years service

vide a clean, smooth shaping action so that the wet, newly-shaped pieces look as though they have just come through a glazing operation.

Before carbides were used, the Scio grinding room was a busy place. It was an absolute must to change the steel tools for regrinding every 8 hours. Every time the tools were changed, *Fig.* 4, several dozen pieces of ware were lost. What was worse, the steel tools had to be scrapped in about 2 to 3 months. Illustration in *Fig.* 5 indicates the size of the tools used, and provides an idea of how much metal is worn away through the abrasive action of the clay. Production-wise, the results with carbide tools were surprising. One carbide hollow-ware tool, for example, produced 195,700 dozen cups (2,348,400 individual pieces of ware) before regrinding was necessary. A 5-inch plate tool produced 125,520 dozen pieces, and a cereal bowl tool produced 144,900 dozen pieces before regrinding was necessary. As an average, a single carbide tool outproduces more than ten of the formerly used steel tools.

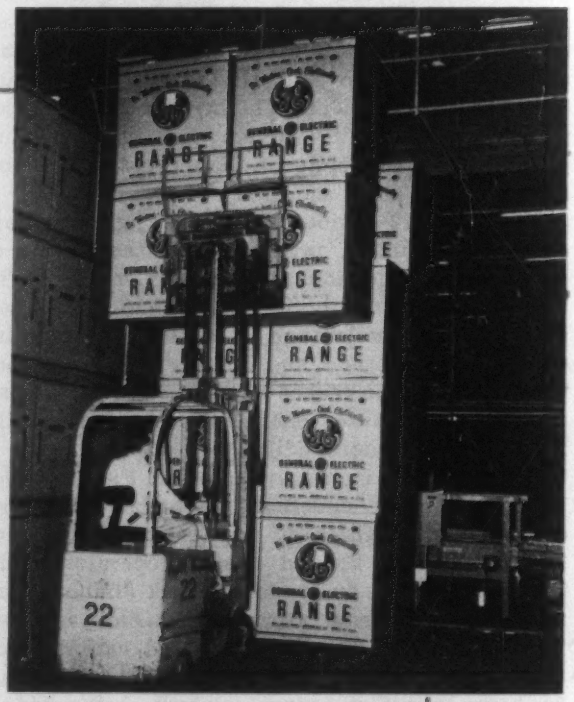
Applications of carbide tools not only jumped production, but also eliminated many of the regrinding headaches. Since the carbide tools only require regrinding every three to eight weeks, the tool supervisor is free to devote more of his time trouble-shooting in other areas. Total life of the tools has been amazing. Some of the original carbide tools placed in operation four years ago are still in use.

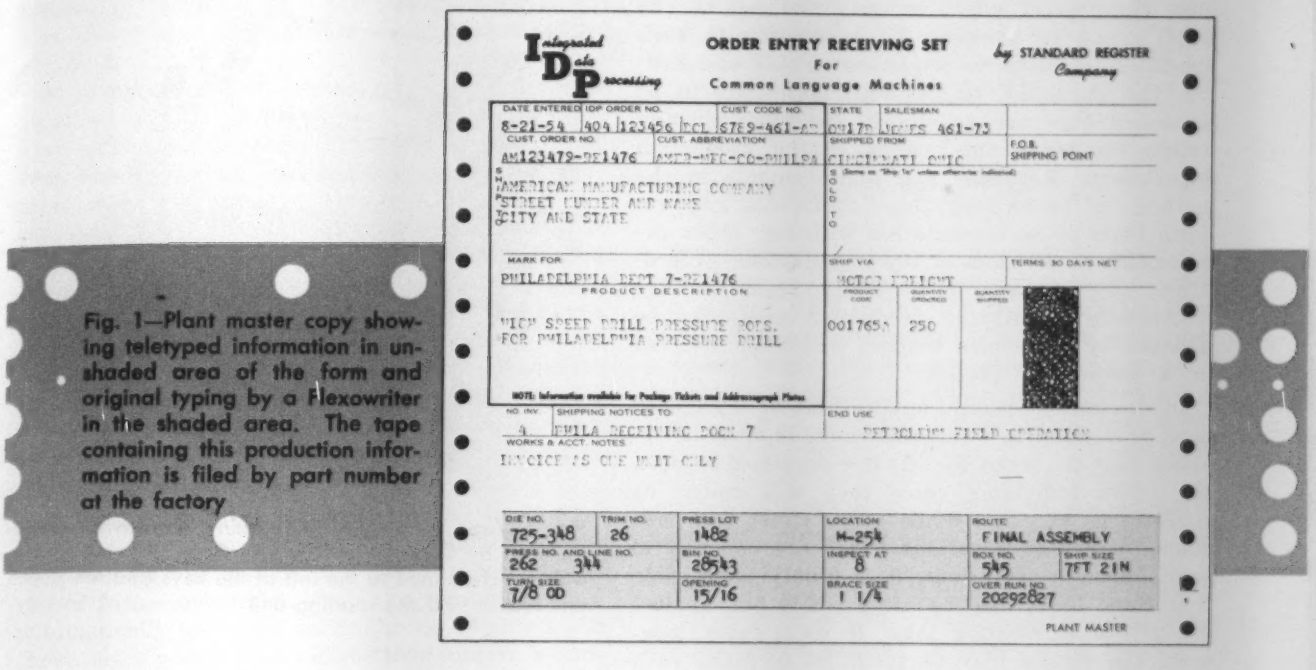
The grade of carbide used for these tools, known as Carboloy grade 883, is produced in solid pieces and provides high resistance to the abrasive action of the clay. Custom-made by Carboloy Department of General Electric Company the knives are preformed to the shapes required for the various wares.

This application of carbide tools to an industry relatively distant from the metalworking industry where they were developed is an illustration of the type of industrial interchange which is highly rewarding but all too frequently lacking.

FINGER LIFT TRUCK

Conventional forks have been removed from fork trucks in a General Electric appliance plant and replaced with finger lifts. Small metal fingers slip beneath the top flange of a special three piece cap and tube fibre container manufactured by Inland Container Corp. As can be seen, four electric ranges can be handled at one time in an operation which requires no pallets for movement and storage. During the six months the new container has been in use, it has effected an 80-per cent reduction in handling and transportation damage; reduced materials cost by 20 per cent; and increased by 25 per cent the finished goods warehouse space because of its greater stacking strength. Strength of carton permits stacking the electric ranges five high compared to limit of four when wood crates were used.





Integrated Data Processing

ORDER ENTRY RECEIVING SET
For
Common Language Machines

by STANDARD REGISTER Company

DATE ENTERED | IDP ORDER NO. | CUST. CODE NO. | STATE | SALESMAN
8-21-54 | 404 123456 DCL | 67E9-461-AM | OHIO | JONES 461-73

CUST. ORDER NO. | CUST. ABBREVIATION | SHIPPED FROM | F.O.B. SHIPPING POINT
AM123479-DE1476 | AMER-MFG-CO-PHILSA | CINCINNATI OHIO

SOLD TO
AMERICAN MANUFACTURING COMPANY
STREET NUMBER AND NAME
CITY AND STATE

MARK FOR | SHIP VIA | TERMS 30 DAYS NET
PHILADELPHIA DEPT 7-DE1476 | MOTOR FREIGHT

PRODUCT DESCRIPTION | PRODUCT CODE | QUANTITY ORDERED | QUANTITY SHIPPED
HIGH SPEED DRILL PRESSURE PTS. FOR PHILADELPHIA PRESSURE DRILL | 0017654 | 250

NOTE: Information available for Package Tickets and Addressograph Plates

NO. INV. | SHIPPING NOTICES TO: | END USE
4 | PHILA RECEIVING DOCK 7 | DETROIT FIELD OPERATION

WORKS & ACCT. NOTES
INVOICE AS ONE UNIT ONLY

DIE NO.	TRIM NO.	PRESS LOT	LOCATION	ROUTE
725-348	26	1482	M-254	FINAL ASSEMBLY

PRESS NO. AND LINE NO.	BIN NO.	INSPECT AT	BOX NO.	SHIP SIZE
262 344	28543	8	545	7FT 2IN

TURN SIZE	OPENING	BRACE SIZE	OVER RUN NO.
7/8 OD	15/16	1 1/4	20292827

PLANT MASTER

Fig. 1—Plant master copy showing teletyped information in unshaded area of the form and original typing by a Flexowriter in the shaded area. The tape containing this production information is filed by part number at the factory

PRODUCTION MEN—

PRODUCE YOUR PAPERWORK AUTOMATICALLY

By P. B. GARROTT
Director of Market Development
Standard Register Co.
Dayton, Ohio

Automation of paperwork can be just as lucrative as automating production processes. As the paperwork wheel in factory operations squeaks louder, application of integrated data processing may soothe the ears of factory management

EVEN though integrated data processing is basically a very simple idea, efforts to relate it effectively to broaden areas of business operation in general terms necessarily involve certain dangers of distortion. In other words, we may become so engrossed in our analysis of the forest that we overlook the valuable characteristics of many individual trees in our immediate vicinity. Accordingly, while the primary subject of this article is integrated data processing, it will depart from abstract principle and theory of this idea, concentrating instead upon certain specific applications of these principles.

While it is certainly true that integrated data processing will be most profitable in those cases where it is applied across the board from the beginning to the end of a complete paperwork control system, it is also true that many highly worthwhile spot applications of these same ideas are possible. Further, since such limited applications of integrated data processing

may have direct effect on only one job or one small group of workers, its application to such operations is often accomplished quickly and easily. The examples, suggestions, and ideas to be presented here are usually to be found entirely within the scope and control of the production department. Revisions and improvements in the methods of performing these operations may require little or no consultation with any other departments or divisions of the organization. Accordingly, any of these ideas which seem to offer worthwhile benefits to production men may be adopted by these men without becoming involved in a large-scale project.

In discussing specific applications of integrated data processing to production jobs, it must be realized that the more specific our examples become, the fewer individual cases they will match or conform to exactly. While every effort has been made to include situations which are common to most business operations, it is highly improbable that these ideas may be lifted bodily and applied directly to all existing jobs. In most cases, however, the details may be modified to make each idea conform to the circumstances existing in each plant.

Fig. 2—Tape reading and punching Flexowriter manufactured by Commercial Controls Corp. showing reader with punched tape to the left of the keys and the punch unit just behind the reading unit

Repetitive Instructions

Let's begin with a rather simple example of one of the ways in which punched paper tape may be made to serve as a production tool. One type of manufacturing order which might be involved in an integrated data processing system is shown in *Fig.* 1. In this case, this production order was prepared in the plant on the receiving machine of a wire communications circuit—operated automatically by the operation of a similar machine at the other end of the circuit in a sales office. Under these circumstances, all of the information typed in the upper, unshaded area of this work order was typed automatically by the wire communications machine. It contains all the basic information which was available from the sales office, including the general items which describe *who* wanted *what* shipped *where*.

In some cases, information typed in the unshaded area of this form might be entirely sufficient to permit the plant to begin processing of this customer's order. In other cases, however, additional information must be placed on that production order before manufacturing operations begin. Additional data might be called by any of several names, such as SOP (Standard Operating Procedures) or SPI (Standard Practice Instructions). These describe what has been found to be the best combination of machines and equipment, and the best sequence of operations for production of a certain item. Each time that item is to be manufactured, these instructions prescribe and define the circumstances under which production is to take place.

Regardless of whether a partially prewritten production order (as in the case of this example) is involved, or whether the plant originates the production order in its entirety, where such standardized operating procedures are in use, they must be shown on the production order. Since such manufacturing instructions are necessarily repetitive by nature, this sort of situation may often be simplified by the use of punched paper tape.

Under conventional circumstances, standard manufacturing instructions for each regularly manufactured item may be recorded in master operations file from which they will be copied onto the related production orders as required. Under such circumstances, the manual transcription (with its related checking or proof-reading) can be eliminated.

Depending upon circumstances, several types of common language machines might be used to mechanize the job involved. One of these is a tape-reading, tape-punching typewriter; another is a tape-reading, tape-punching wire communications machine. Both of these units are capable of performing the same basic types of operations, with the exception that wire communications equipment may also be operated from far-distant points. Regardless of which of these types of tape-operated units were used to produce the manufacturing order, insertion of standard manufacturing instructions could be made a mechanical rather than a manual operation.

To accomplish this desirable objective would require that each standard operating instruction be punched into a strip of paper tape, carefully checked for accuracy and completeness, then filed by part or item number. It is probable that instructions for manufacturing each part would be maintained in file in two forms; first, in the form of a typed document which people may read and,

second, in the form of a strip of punched paper tape which the production-order writing machine can read.

Manufacturing instructions for each order can be added rapidly, accurately, and automatically. As soon as the part or item to be manufactured had been identified, the corresponding master instructions tape would then be removed from file, inserted into the reading mechanism of the machine involved, and used to add instructions to the manufacturing order. In general, this sort of operation is possible regardless of whether the manufacturing order is received by wire circuit or is originated in the plant. Incorporation of manufacturing instructions may be included in the writing of the production order itself or may be handled as a secondary and subsequent operation, depending upon circumstances.

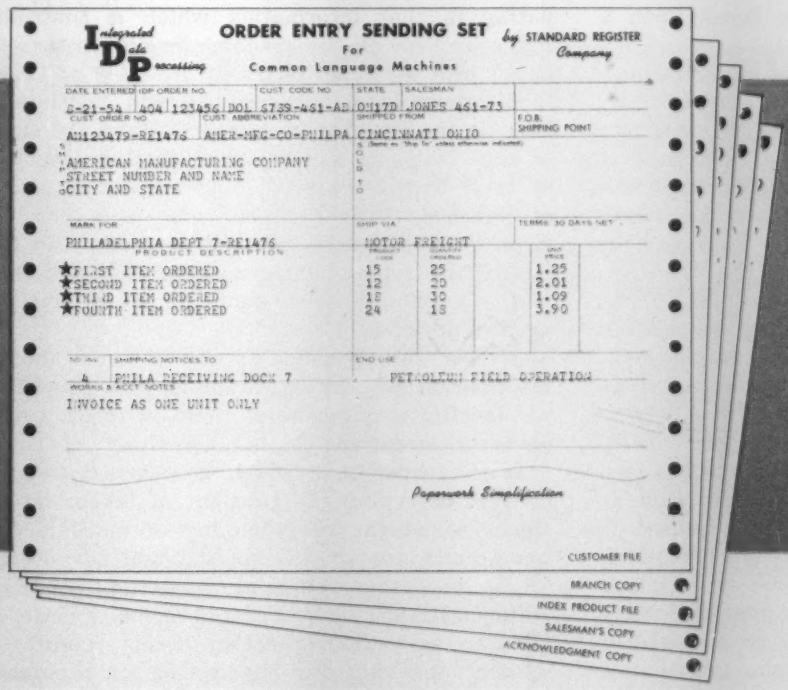
It is obvious in this example that we have done nothing more than convert our standard manufacturing instructions in each case to a mechanical record form—one which is able to reproduce itself automatically as often as might be required. In those cases where such instructions involve a considerable amount of information, one of the advantages might lie in the fact that information can be placed on the production order much more rapidly—hence at lower cost—than can be accomplished by manual transcription. In any event, one undeniable benefit offered by this simple idea lies in accuracy. Standard manufacturing procedures are developed with the greatest care, after extensive investigation and planning have determined the most efficient pattern. Such careful planning is rendered useless, unless the resulting instructions are followed exactly. Punched paper tape and the use of machines which may be operated automatically by such tape offer assurance that these carefully formulated instructions will appear accurately and completely on every order where their use is indicated.

▶ Preparation of Parts Tags

Previous examples and discussions have concerned the use of punched paper tapes as a means for storing information for reuse at later dates or in different locations. There are situations, however, which involve the repeated reuse of information immediately, as in the preparation of parts tags or shipping labels. In preparing material for shipment or storage, it is often necessary that a number of tags or labels be prepared; the number of documents varying widely depending upon the quantities involved in the particular transaction.

Let's visualize an organization which ships its product in standard cartons, each containing a predetermined number of units. The number of cartons involved in any one shipment will be dependent upon the quantity of the units ordered by a particular customer. Accordingly, the shipment for one customer's order may involve one carton, ten cartons, or several hundred cartons.

The example which follows is particularly applicable in cases where the average number of cartons or items to be identified is less than three dozen, although it might be applied under certain circumstances which required larger quantities. Although this trick may be worked with wire communications equipment as well as with the


Integrated Data Processing

ORDER ENTRY SENDING SET For Common Language Machines by STANDARD REGISTER Company

DATE ENTERED | IDP ORDER NO. | CUST. CODE NO. | STATE | SALESMAN
6-21-54 | 404 | 123456 | DOL | 6739-461-AD | OH17D | JONES 461-73

CUST. ORDER NO. | CUST. ABBREVIATION | SHIPPED FROM | F.O.B. SHIPPING POINT
AH123479-RE1476 | AMER-MFG-CO-PHILPA | CINCINNATI OHIO

SOLD TO: AMERICAN MANUFACTURING COMPANY
STREET NUMBER AND NAME
CITY AND STATE

SHIP TO: (Same as "Ship To" unless otherwise indicated)

MARK FOR: PHILADELPHIA DEPT 7-RE1476 | SHIP VIA: MOTOR FREIGHT | TERMS: 30 DAYS NET

PRODUCT DESCRIPTION	PRODUCT NO.	QUANTITY ORDERED	UNIT PRICE
★FIRST ITEM ORDERED	15	25	1.25
★SECOND ITEM ORDERED	12	20	2.01
★THIRD ITEM ORDERED	18	30	1.09
★FOURTH ITEM ORDERED	24	18	3.90

NO. OF | SHIPPING NOTICES TO | END USE
4 | PHILA RECEIVING DOCK 7 | PETROLEUM FIELD OPERATION

WORKS & ACCT. NOTES
INVOICE AS ONE UNIT ONLY

Paperwork Simplification

CUSTOMER FILE
BRANCH COPY
INDEX PRODUCT FILE
SALESMAN'S COPY
ACKNOWLEDGMENT COPY

Fig. 3—Multiple-item order form as received from the sales office. This type of form is desirable from a sales viewpoint but is usually not suitable as a production order.

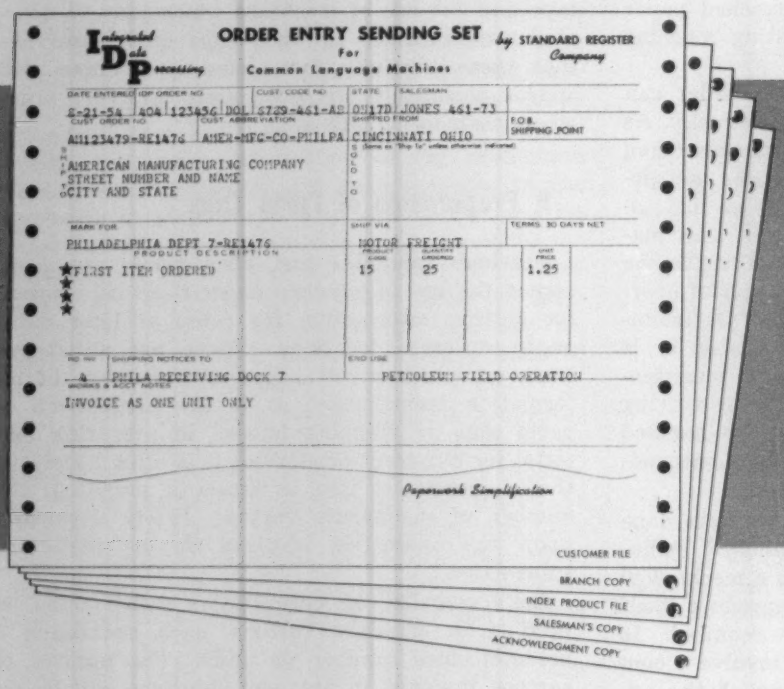


Fig. 4—Single-item order showing the first item from the multiple-item order. Breakdown into single-items can be effected using either wire communications equipment or a tape-reading, tape-punching typewriter

tape-reading, tape-punching typewriter, the latter will be used in this illustration since its physical arrangement permits easier reference.

Assuming that we have an order in our hypothetical organization and that it calls for the shipment of 24 cartons of product, let's see how this idea can help us in the preparation of identification for those cartons. Suppose that we have a tape-reading, tape-punching typewriter equipped with continuous label forms, each set of which contains an original and five carbons—giving us a total of six labels per set. Our requirement is for 24 labels, which means that the necessary shipping information needs to be typed upon 4 such sets of 6-part labels.

The necessary quantity of labels might be produced by manual operation of the keyboard by an operator who would repeat the shipping information the four times required. Repetition of the basic information in the manual method can be eliminated by taking advantage of the special units built into the Flexowriter. Suppose, for example, that our operator typed the basic information on the first set of labels and, at the same time, caused that information to be punched into a strip of tape by the tape-punching unit. Since the tape-punching unit is directly behind the tape-reading unit, *Fig.* 2, the head end of that new tape can be inserted into the reading mechanism. With the punched tape which was a by-product of the typing of the first label now in the reading unit, the machine can be caused to operate itself automatically to repeat that basic shipping information upon the second set of labels.

At the same time, since the tape-punching mechanism is still in operation, as the second label is being typed automatically the same information is being duplicated again in a new section of the tape. Since the tape is a continuous strip which has not been detached from the punching unit, the tail end of the first portion of the tape is followed by the head end of the same information punched into the second portion of the tape. In this way, each time that a set of labels is typed, the same basic information is duplicated in the next section of tape which will be fed into the reading unit automatically. As that section of the tape is read and operates the machine, the information it contains will again be duplicated in the following section of tape. This procedure is truly self-perpetuating in that information which is controlling the operation of the machine is also being "fed back" into the tape, resulting in a sort of "closed loop" control. This operation will continue as long as the machine is turned ON and the supply of tape lasts. It will be noted that for every set of label forms produced, a corresponding section of punched paper tape has also been produced. Each such section of punched paper tape, in turn, caused the typing of the next set of label forms and the simultaneous punching of a duplicate section of tape.

In this way, a single typing of basic shipping information by the operator may be duplicated an indefinite number of times without further operator attention. It is understood, of course, that the paper tape which is punched as a by-product of typing the first set of labels, also includes all of the programming of machine functions which control the spacing and advancement of the label forms which are in writing position.

Punched tape devices might be applied to any label or tag-writing operation of this general type, without involving any changes at other points in

the organization. We can go a step further, however, if we consider the possibility of eliminating even that initial manual typing of the basic shipping information by a human operator. Suppose, for example, that we could secure the basic shipping information in the form of punched paper tape from some earlier step in the transaction. Such a tape might be produced as an automatic by-product of the preparation of a shipping order. With such a tape at hand, we could use it to operate the reading mechanism of the machine to type the first set of labels; at the same time preparing the first section of the continuous tape.

▸ Single and Multiple-Item Orders

When the sales department gets a purchase order from one of its customers, it generally prefers to handle that order as single, neat package, even though the order may call for an ill-assorted variety of products. From the production man's point of view, however, it may be out of the question to process such orders as a single unit. Because of the variety of products involved, different production processes are almost certain to be required. In many cases, this means that a multiple-item order, upon receipt at the production plant, must be converted into a number of individual orders, each containing only one of the items specified on the customer's purchase order. Later, of course, all of the individual items may again be reassembled into a single shipment for delivery to the cutomer. During the manufacturing process, however, it is not unusual for each item to require its own manufacturing order to permit production of all items to proceed simultaneously without interference or delay.

Suppose that *Fig.* 3 represents an order in the form the sales department prefers to handle. This order contains four different items. Probably, those same four items appeared on the customer's purchase order which the sales department received, and are shown on this acknowledgment in the same way so that the customer can relate the acknowledgment to the order which he placed originally.

Assuming that sales offices and plant are connected by wire communications circuits, the chances are that the production copy of this order would be received on the plant Teletypewriter in practically the same form—a multiple-item order. Another unit of wire communications equipment might be connected to the receiving machine in such a way that each incoming order appeared not only as a typed document but, also, as a strip of punched paper tape.

In these situations, transmission of this order to the plant from the sales office would have been planned in such a way that the punched paper tape created in the plant would contain certain special provisions. That tape would contain a special signal code at each of the points marked by a star on the typed copy of the order. One such code would appear at the end of the heading information, or between the end of the heading and the beginning of the first item on the order. Correspondingly, a similar signal would appear between the first and second items, between the second and third items, and between the third and fourth items, etc.

In order to break this multiple-item order down into individual-item production orders, we may use either of two basic types of common language

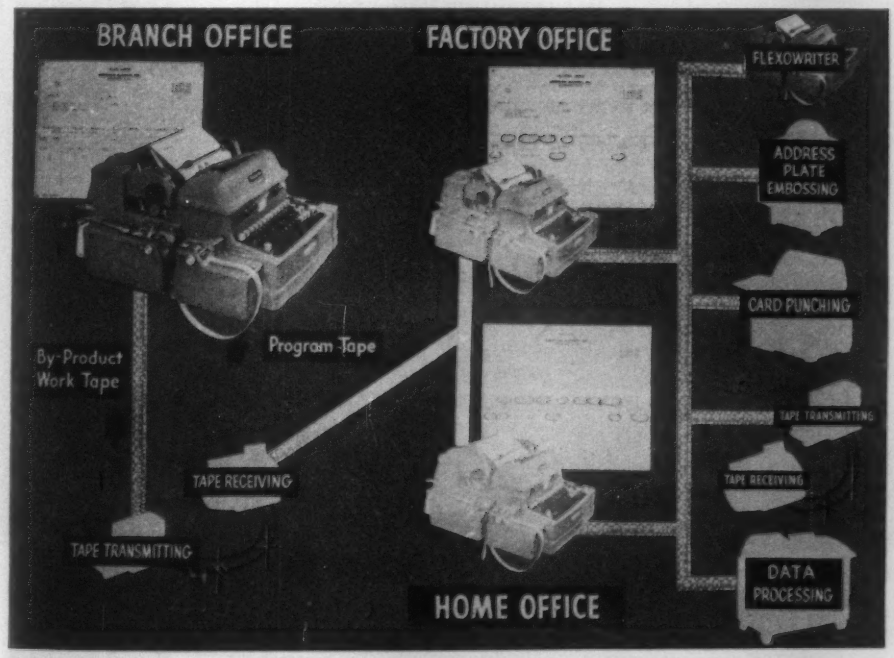


Fig. 5 — Systems application requiring form control and automatic selection of information to be punched into work tape. The Flexowriter can automatically perform all required spacing functions both vertically and horizontally

machines. Depending upon circumstances, the same wire communications equipment which received the order from the sales office might now be used to prepare individual-item production orders. Under other circumstances, it might be more practical to employ a tape-reading, tape-punching typewriter to perform the job.

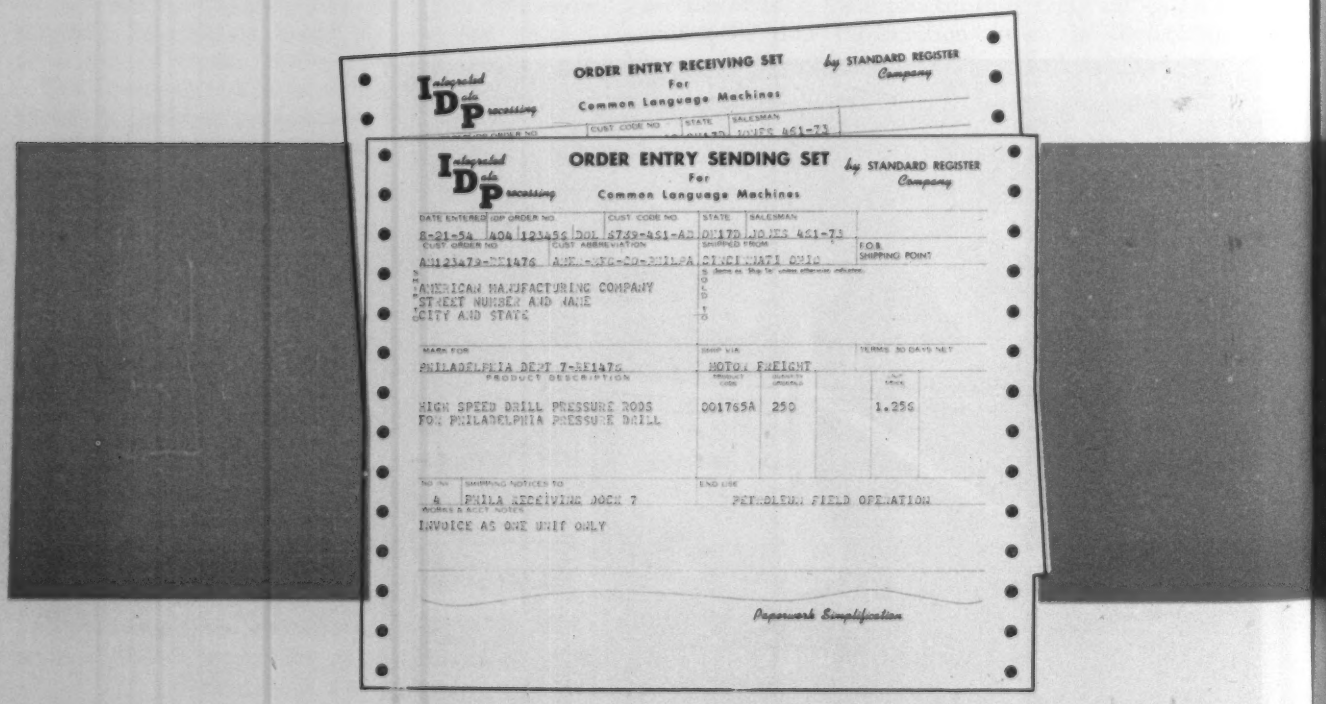
In either event, the specially coded tape is inserted into the reading mechanism of the machine to be used. The machine is equipped with forms of the construction and design needed to serve the plant's purposes. The tape causes the heading information to be typed automatically on the first such form. The machine stops after the heading information has been inserted because of the special code which was mentioned earlier. This gives the operator an opportunity to determine which of the items on the order is to appear on this particular production order. In this case, since we've just started the breakdown job, we want to prepare a production order for the first item on the customer's order. Consequently, we simply start the tape-reading mechanism again, permitting it to fill in the body of the first production order with the details concerning the first item. Upon completion of the description of the first item, the machine will stop again.

At this point, we have, in effect, picked off the first item on the customer's order and prepared a manufacturing order covering it, *Fig.* 4. Our next step is to prepare corresponding orders for each of the individual items remaining on the customer's order.

To accomplish this, we simply advance the forms in the machine to the heading of the next production order; reinsert the tape at its beginning; permit it to retype the heading on the second production order much as we did in the first step. When the machine stops at the end of the heading information, however, we now advance the tape to the special signal code following the first item and preceding the second item. At that point we let the tape operate the machine to type in the details concerning the second item on the customer's order. This information will fall in the same relative area in which the first item information fell on the first production order.

The individual-item production order for the third item on the customer's order is produced in the same manner; letting the tape rewrite the heading portion of the order; skipping over Item 1 and Item 2; and letting the tape type the details regarding Item 3 on the third production order. In the same manner, a single-item production order is prepared for each item on the order, regardless of number.

Thus, receiving our multiple-item order information in the form of a punched paper tape from the sales office, we have used that punched paper tape to rewrite four production orders. The heading and general information on each of these orders is identical, having been typed mechanically and automatically from the same tape. The body of each of these individual orders, however, con-



tains the details concerning only one of the four items which appeared on the original order.

One of the advantages of this sort of operation is the fact that such typing and retyping can be done much more rapidly and at much lower cost by these automatic means than by manual transcription. Further, by making such transcriptions mechanically and automatically, we avoid the very real danger of transpositions and other errors which inevitably occur through human copying.

▸ Bills of Material

Several types of office machines are capable of being connected by wire or cable to provide tandem operation of two or more units by a single operator. Obviously, this is true in the case of wire communications equipment which is by nature a class of wire-connected machines. In a somewhat similar fashion, however, other office machines may also be connected in tandem to meet the needs of special jobs. To illustrate one such possibility, let's consider another common manufacturing requirement which exists in connection with bills of material.

The bill of material, itself, can be an ideal subject for application of the punched paper tape method. Once the various components and assemblies of a product have been determined and defined, a bill of material is often referred to rather frequently during the production process. One such referral may occur when a production lot of the product involved is to be manufactured. In this case, material requisitions, or stock withdrawal documents, must be prepared to cause the removal from inventory of various components which are to be assembled into the final product. It is conceivable that a single punched paper tape might be able to accomplish both of these jobs at once by the use of tape-reading, tape-punching machines which are connected in some sort of duplex or tandem arrangement. Since everyone is relatively familiar with the ordinary typewriter, let's stick to the tape-reading, tape-punching typewriter as the machine involved in our example, in spite of the fact that other types of equipment might be used under certain circumstances.

This bill of material operation might involve the use of two tape-reading, tape-punching typewriters, connected by cable so that both could be operated from the keyboard or tape-reading unit of one of the machines, *Fig.* 5. Other physical preparation for conducting a job of this kind would involve the punching of bill of material master tapes for each major product involved. These tapes would contain the same basic information which makes up the bill of material itself, but would be in punched paper tape form to permit use and reuse by mechanical means.

With such a tape in the reading unit of the "master" machine, and with bill of material forms in the master machine and material requisition forms in the "slave" machine, two separate but related jobs could proceed simultaneously. By means of proper planning, programming, and forms design, the slave machine could be producing a material requisition for each item being typed on the bill of material on the master machine. In such an operation, the slave machine might be writing a one-line material requisition on a 3½-inch deep document at the same time that the same

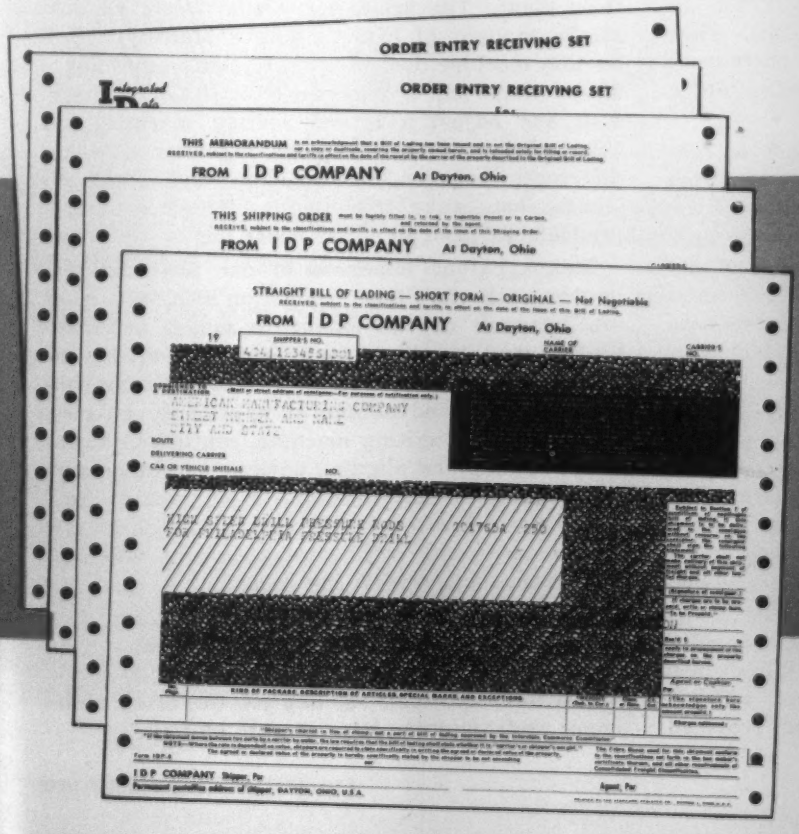

ORDER ENTRY RECEIVING SET
ORDER ENTRY RECEIVING SET
THIS MEMORANDUM
FROM I D P COMPANY At Dayton, Ohio
THIS SHIPPING ORDER
FROM I D P COMPANY At Dayton, Ohio
STRAIGHT BILL OF LADING — SHORT FORM — ORIGINAL — Not Negotiable
FROM I D P COMPANY At Dayton, Ohio
I D P COMPANY Shipper, Per
Agent, Per

Fig. 6—The first form, order entry sending, is prepared in the sales office on a sending machine of the wire communications circuit. The second form, order entry receiving, is typed in the production department simultaneously with the first form. The third set of forms is produced in the shipping department

line was being typed as part of a six-to-the-inch listing on the bill of material form in the master machine. This would involve forms feeding and spacing arrangement of considerably different characteristics on the two machines. However, since many such special arrangements have been developed and are in productive operation, it should be sufficient to say that their application to a specific job is little more than a detail.

▶ Expanded Operation

In the same general fashion, a number of different but closely related documents may be produced simultaneously by the use of tandem machines. To hark back to an earlier example, suppose that a plant was receiving its production orders from a sales office by way of a wire communications circuit. It is reasonable to assume that every order so received is going to be shipped. Under these circumstances, it is possible in many cases to provide another branch of the wire communications circuit running to the shipping department of the plant. There, at the same time that the customer's order is recorded in the production office of the plant, the shipping department could be receiving a prewritten set of shipping papers which might include bills of lading, packing slips, labels, etc. This is a possibility in view of the fact that much of the information which is needed on shipping papers is identical to information which appears on the order entry sending and receiving forms, illustrated in *Fig.* 6.

The order entry sending set is prepared in a sales office on the sending machine of a wire communications circuit. This set of forms contains basic information regarding the transaction, but is typed upon a document designed and constructed to meet the requirements of the sales office. That set includes the salesman's copy; the customer's acknowledgment copy; and various sales office file copies.

At the same time that a set of forms is prepared in the sales office, the second set of forms is being typed in the production department of the plant involved. Both sets are typed simultaneously since they are in machines at opposite ends of the same wire communications circuit and are operated in tandem. In general, the second set of forms contains information needed to advise the plant *who* wants *what* shipped *where*.

Since the shipment of the finished material is a very essential part of the transaction, a third set of forms is also produced simultaneously on another branch of the receiving circuit located in the shipping department. At this point, the receiving wire-communications machine uses the same basic information common to the other two documents, but types it on a form of entirely different design and construction. This set includes the conventional bills of lading copies, plus other copies which may serve the purposes of packing slips and labels—the label copies being provided by perforations which permit the upper left corner of those copies to be detached for use as labels.

In considering this variety of examples, keep in mind that each represents only a very limited portion of integrated data processing. In connection with each of the illustrations cited, a great many other possibilities exist and might be discussed in connection with the origin and use of the tapes involved. Under certain circumstances, the advantages and benefits cited in connection with these examples might be increased considerably by careful analysis of the basic information involved. Investigation might disclose that still more manual operations might be eliminated simply by back-tracking along the line of flow of information, and arranging to secure the desired tape automatically as a by-product of some preceding operation. In the same fashion consideration should be given to others in the organization who may have occasion to use the same information after the particular operation involved. It might be possible to provide this information to other individuals in the form of another by-product punched paper tape with little or no extra effort or costs. Such a simple provision might serve to reduce costs and errors in subsequent steps to a surprising degree.

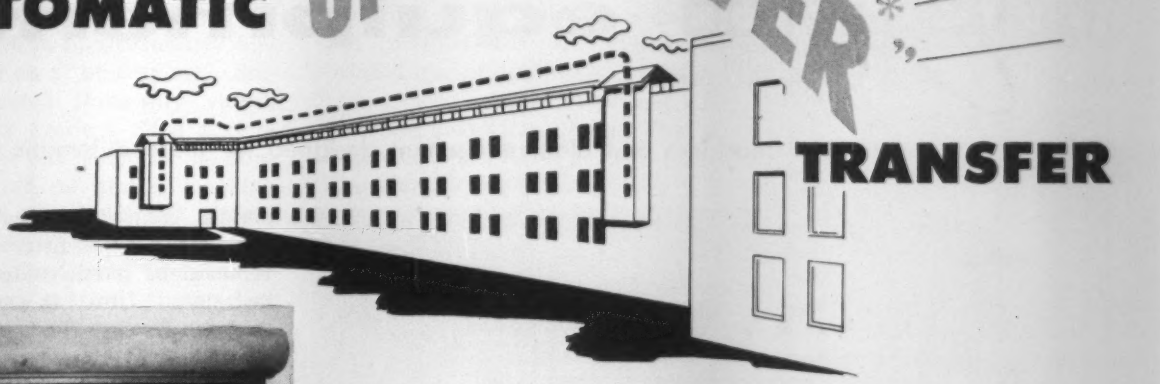
▶ Automate Paperwork, Too

Any production man appreciates the fundamental importance of keeping setup and maintenance time to a minimum in relation to running time of a production unit. Strangely enough, however, many production men fail to realize that exactly the same principle applies in the production of the papers required for the operation of their plant. The same fellow who would shudder at the thought of hand-feeding a high-speed production machine doesn't seem to think anything at all of requiring a paperwork operator to hand-feed and adjust a record writing machine. All this in spite of the fact that, in either case, the difference between hand-feeding and automatic feeding can make tremendous differences in the productive output of either operation.

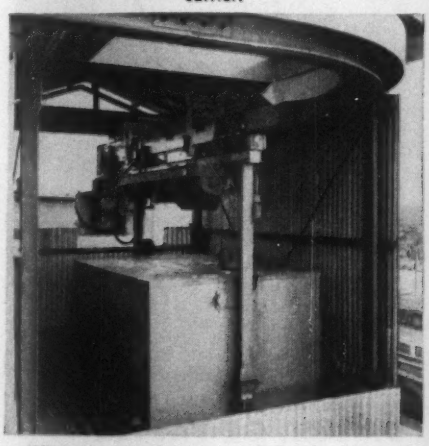
This apparent blindness in one direction may be due to the fact that production men, as a class, are unaware of the extent to which automatic feeding and handling equipment is available for application to their necessary record writing jobs. By taking full advantage of a properly balanced combination of writing machine, continuous forms, forms feeding and aligning devices, and other units for auxiliary forms handling, it is possible for a paperwork operator to produce hundreds of necessary documents without once raising her hands from the keyboard of the machine.

While production men are prone to look down their noses at paperwork operations, no alert manager can afford to ignore the fact that proper use of available tools for *any* job can often reduce labor costs and improve overall efficiency.

AUTOMATIC "UP AND OVER" TRANSFER



Three boxes—450 lbs. each—are loaded in car. When doors are closed the car raises to carrier.

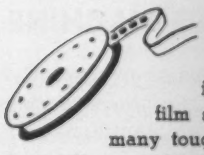


When car reaches upper limit, the Mono-Tractor propels carrier on the MonoRail to No. 2 mill.

SAVES $30,000 PER YEAR

Here is an "Up-and-Over"* system that eliminates 72 hours of handling labor per day. It automatically transfers 180 full bobbin boxes from three floors of one mill to one floor of another and returns the empties. Estimated savings in labor, trucks, floors and traffic congestion run upwards of $30,000 per year.

It is another of the many examples of American Mono-Rail engineering for low-cost handling within space limitation. Let one of our field representatives explain further the versatility and low maintenance of American Mono-Rail equipment.



***"UP-AND-OVER"**

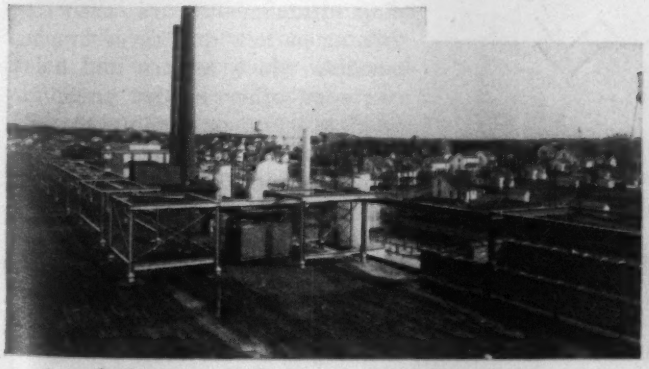
is the title of our 16-mm. sound film showing how MonoRail solves many tough handling problems. Please allow us three weeks to schedule showing.

For Continuous Flow of Light Loads Use Landahl Chainless Conveyors

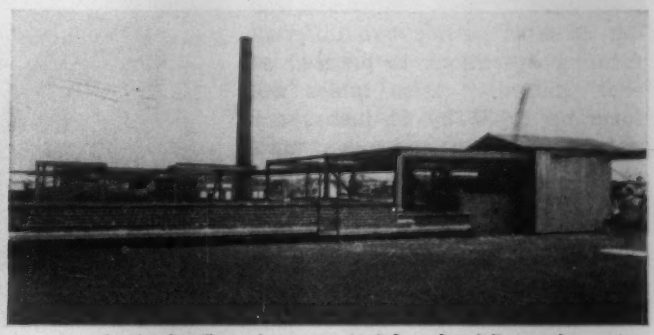
AMERICAN MONORAIL COMPANY

OVERHEAD HANDLING EQUIPMENT

13144 ATHENS AVENUE • CLEVELAND 7, OHIO



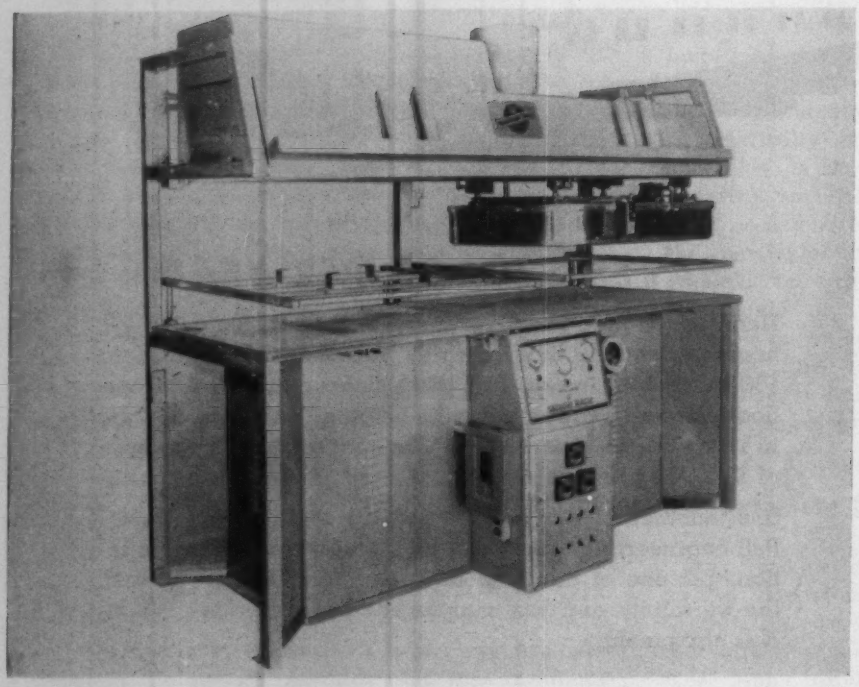
Carrier travels at 50 f.p.m. around curves—150 f.p.m. on straight track with slow approach at towers.



At No. 2 mill car lowers to third floor for delivery of full boxes and return dispatch of empties.

AUTOMATION new equipment

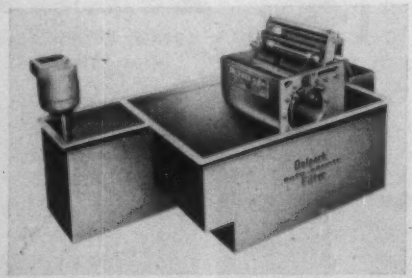
Machines and plant equipment designed for more automatic operations



AUTOMATIC VACUUM FORMING MACHINE

Designed to widen the scope of operation in vacuum forming of plastic sheet materials, new machine has two operating stations adjacent to each other with a traveling oven. This design permits one man operation for materials whose heating and forming cycle is slow enough so that during the heating cycle of one sheet the operator may be removing and reloading the opposite station. On faster cycling two operators may work side by side. Separate timing controls permit two different forming operations to proceed on each station. Base tables will form up to 31 by 41 inches and extension tables and oven units are available to permit handling of sheets up to 60 by 96 inches. For deep draw parts requiring plug and ring forming, special presses with air cylinders may be obtained to mount at either end of the machine. Sheets are heated by extension ovens. Cycling operation of the sheet carriers is pneumatic. Oven contains height adjustment features for obtaining desired heating characteristics. **Whitlock Co.**, 3655 N. Southport Ave., Chicago 13, Ill.

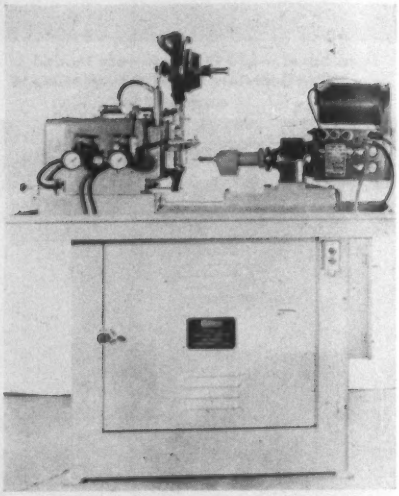
Circle No. **1** *on Reply Card*



AUTOMATIC FILTER

Rotary gravity type filter provides full flow filtration of coolants, cutting oils and industrial fluids. Feature of the filter is a permanent type filter screen for removal of particles to 0.002-inch in size. Unit is self-cleaning through reverse flush principle operating on a time lapse sequence. Residue cleaned from the bar stock type screen is removed by chain driven flights. Filter requires only the removal of the residue and sludge from the tote box under the carry off shelf. **Industrial Filtration Co.**, Dept. R-471, Lebanon, Ind.

Circle No. **2** *on Reply Card*

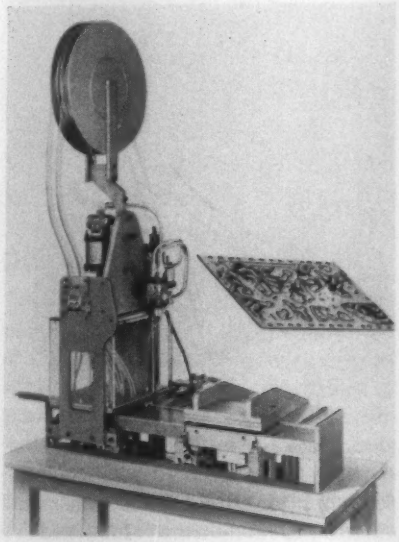


DRILLER OR TAPPER

Automatically self-reversing tapping attachments are used for tapping on new drilling or tapping machine which locates and holds rivets or other headed parts for axial tapping, or drilling to very thin walls. Machine performs without out-of-round distortion, and centers with the axis of the parts. Changeover from drilling to tapping is accomplished in approximately 10 minutes. Tanks containing different coolants are exchanged in less than 2 minutes, eliminating necessity of cleaning

out the machine base and storing the unused coolant in other containers when changing from drilling to tapping. Machine operates by electrically controlled compressed air on minimum 50-psi air line pressure at approximately 500 strokes per cu ft of free air. Solenoid actuated three-way valves regulate the cycling. If a part is not properly positioned or the hopper runs out of parts, machine shuts itself off. Being air driven, hoppers are not susceptible to damage in the event oversize or foreign parts get into them; drill breakage caused by hard spots in the work is also considerably reduced. Machine is adaptable to hollow milling, centering, step drilling, countersinking, spot facing, reaming and certain combinations of these applications. **Batchelder Engineering Co. Inc.,** 125 Main St., Springfield, Vt.

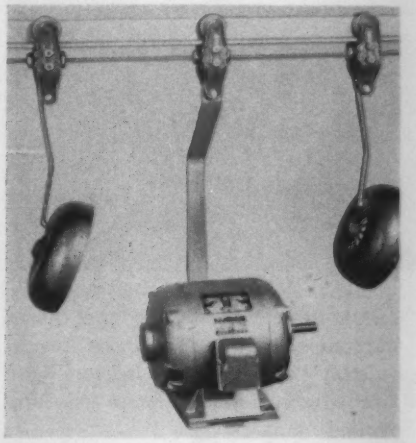
Circle No. **3** *on Reply Card*



TERMINAL INSERTER

Automatic machine inserts up to 40 or more terminal pins or contacts into a printed circuit board within a three-second cycle. Insertion is accomplished simultaneously in any symmetrical or nonsymmetrical pattern. Since the terminal pins or contacts are self-retaining, they will not vibrate loose during additional assembly or other operations prior to permanent soldering. Operation is completely automatic. Terminals or pins in chain form are fed from two reels simultaneously through the cutoff and feeding mechanism into the printed circuit board. Second stage of machine presses pin terminals into the board. Machine and pin terminals provide a means and method for automation of printed circuit applications in electrical, electronic, aviation and automotive industries. **Malco Tool & Mfg. Co.,** Dept. ANC, 4025 W. Lake St., Chicago 24, Ill.

Circle No. **4** *on Reply Card*



CABLE CONVEYOR

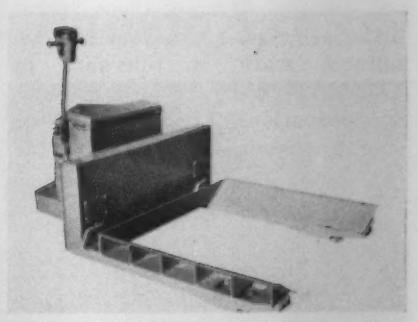
Capable of handling up to 250 lb per hanger, cable-type systems have a continuous conveyor track. The track is prefabricated ¼ by 2 by 2-inch T-rail with all bolted construction. Support rods and mounting brackets are bolted to the track during assembly. Trolley side plates fit into grooves in the cable drive lugs and are bolted into place. Trolleys are available in 80, 150 and 250 lb capacities. Heavy duty trolleys have grease fittings; lighter capacities may be lubricated by a solenoid operated automatic oiler. Electric drive is available with fixed or variable speeds. Friction clutch is optional on the drive unit. Track is available for inclines, vertical bends, quick-dip bends and straight runs. Idle or drive corner sprockets are made in 15¼, 23 or 30½-inch diameters, for either 90 or 180 degree corners. **Tipp Mfg. Co.,** Tipp City, O.

Circle No. **5** *on Reply Card*

ROTARY CODER

Designed for high speed precision operation, rotary coder automatically prints names, dates, codes or other identification. Powered by a friction roller attachment, unit imprints on boxes, cartons, packages and cases. Self-inking feature assures sharp impressions. Baselock interchangeable rubber type or a die which will reproduce the desired imprint may be used. **Krengel Mfg. Co. Inc.,** 227 Fulton St., New York 7, N. Y.

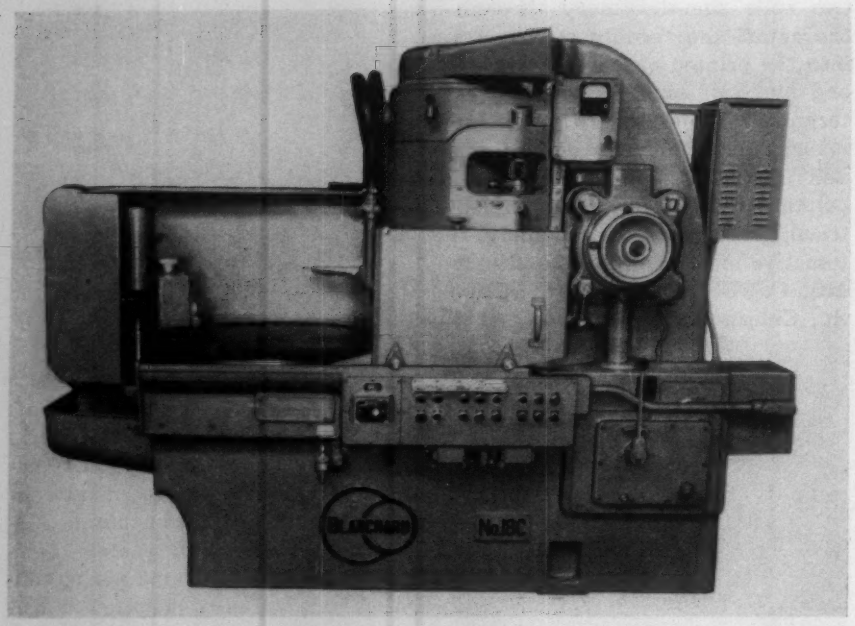
Circle No. **6** *on Reply Card*



ROLL HANDLING UNIT

Operator-led, electric powered truck is equipped with a pair of specially designed forks for handling cylindrical loads. Forks are heavy duty concave units made so that they can straddle drums, reels, cylinders and paper rolls. Electric lift mechanism raises the forks 4 inches, enabling the truck to pick up the cylindrical loads and transport them to the desired location. Unit can be furnished with different overall fork widths and lengths to accommodate loads of different length and diameter. Capacities of two models available are 4000 and 6000 lb. **Automatic Transportation Co.,** 149 W. 87th St., Chicago 20, Ill.

Circle No. **7** *on Reply Card*

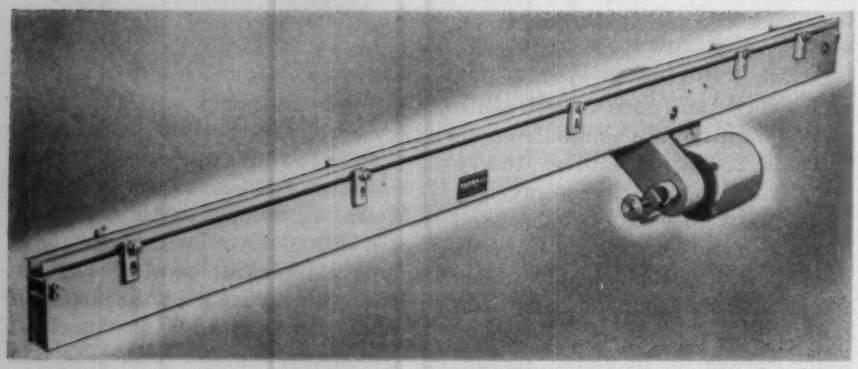


AUTOMATIC CYCLING GRINDER

New machine has been designed to accomplish by means of automatic cycle control most operations performed by an operator when running a standard Blanchard grinder. Among these operations is included size control. On suitable work, a tolerance of ±0.0005-inch can be held in regular production. After initial setup, operator loads the work on the magnetic chuck, closes the direct current circuit to the chuck, presses the "cycle start" button, and the grinder completes the grinding cycle.

The chuck is then returned to loading position without attention from the operator. **Blanchard Machine Co.**, 64 State St., Cambridge 39, Mass.

Circle No. **8** *on Reply Card*



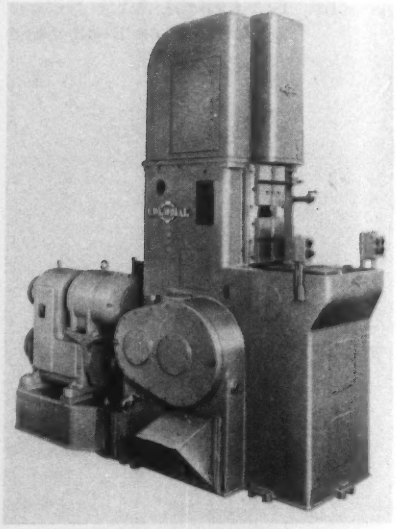
WORK FEEDING TRANSFER CONVEYOR

Developed to transfer cylindrical work from one production operation to another, such as between centerless grinders, inspection machines or polishing machines, transfer conveyor removes work from one machine and delivers it to another automatically. Unit is self-contained and is easily installed between two machines. It consists of a conveyor mechanism, motor and variable speed transmission. Conveyor has a frame only 1¾ inches wide, but has the capacity for parts from ¼ to 1½ inches diameter. Overall length is 62 inches. Power is furnished by a ¼ hp, three-phase motor. **Feedall Inc.**, Willoughby, O.

Circle No. **9** *on Reply Card*

BROACHING MACHINE

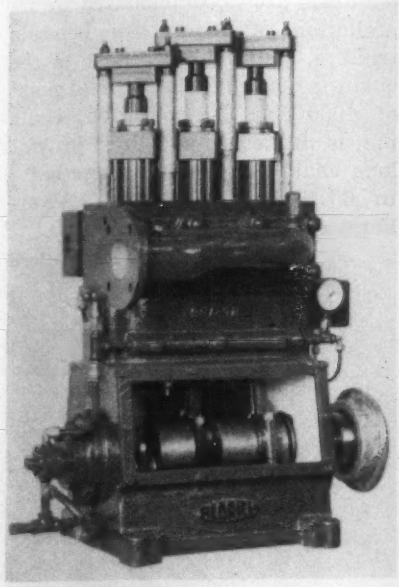
New machine features almost continuous metal removal by mounting a series of broach carriers on an endless chain. Broach carriers move downward on the front of the machine, entering precision ways before contacting the work to insure accuracy. Part being broached remains stationary in suitable holding fixtures on the work platen. After entering the ways, broach carriers become individual rams. Chain applies only down pull on the ram; gibs and ways support the ram while broach teeth are cutting. Chain broach principle provides increased length of broaching stroke in a relatively small machine. Unit is 11½ feet high, with an effective broach length of 12 feet 10 inches. Ma-



chine has an inifinite variation of cutting speed from 10 to 50 surface feet per minute. Pulsations and vibrations sometimes incurred in other drive systems are eliminated by this mechanical drive. If parts being broached require less than half the available stroke, duplicate tooling can be installed in sequence on broach carriers and controls modified to provide two or more broaching cycles for each revolution of the chain. Two parts requiring a short stroke and one part requiring a long stroke can also be broached side by side during a single revolution of the chain, with suitable broach spacing and control stops. Specially designed floating head support for the upper idler sprocket automatically

maintains proper chain tension and compensates for chain and sprocket wear. Tower of the machine is constructed so that it can be raised with extension inserts, and a longer broach carrier chain installed. Additional carriers may then be attached to the chain, increasing the effective broaching stroke from 12 feet 10 inches to as much as 18 feet. **Colonial Broach & Machine Co.**, P. O. Box 37, Harper Station, Detroit 13, Mich.

Circle No. **10** *on Reply Card*

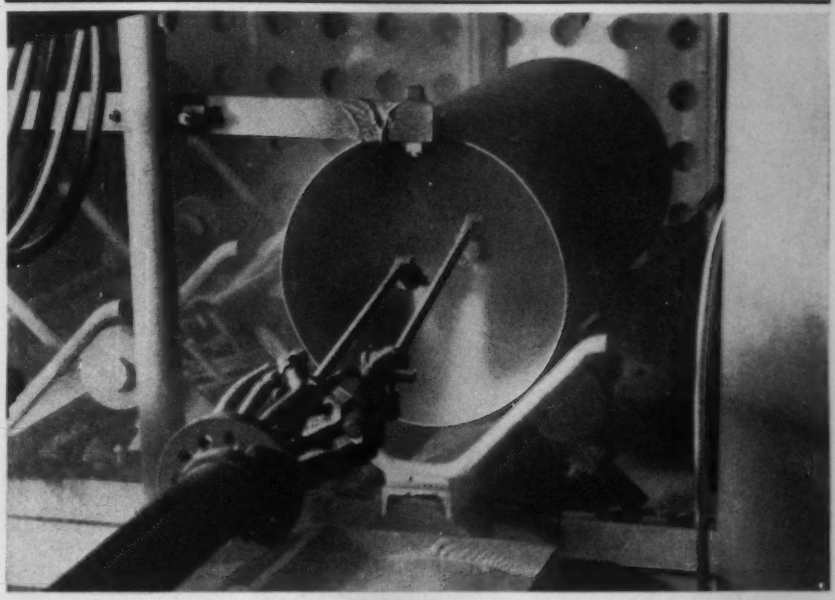


DIRECT FLOW PUMPS

Inverted, vertical reciprocating pumps have the fluid end mounted at the top of the frame, with crankshaft at the bottom, providing a good arrangement for connection with the prime mover. Among features of the pumps are fluid end sectionalization, horizontal valve action, parts standardization and simplicity of construction. Pumps use an odd number of cylinders to obtain minimum flow variation. In the petroleum industry they can be applied to water flooding, propane and butane injection, salt water disposal, lean oil service, and crude and product pipe lines. They can also be used for die casting, plastic and rubber molding and extrusion. asbestos molding and carbon extrusion. Plunger sizes range from 11/32 to 2½-inch diameter; pressures from 390 to 20,700 psi. **Aldrich Pump Co.**, Allentown, Pa.

Circle No. **11** *on Reply Card*

WHAT'S NEW in automatic finishing

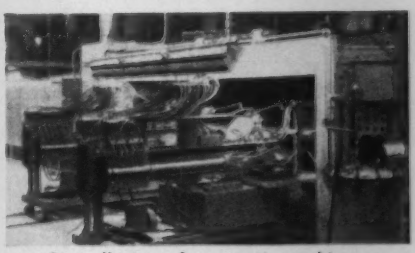


These Binks Model 21V automatic spray guns reach deep into the steel tanks on muscles of steel...apply smooth uniform coating of "glass."

Binks guns automatically spray glass linings in Rheem tanks

Rust and corrosion have long plagued the owners of water heaters. To lick this problem, the Rheem Manufacturing Company, world's largest maker of automatic storage water heaters, developed Rheemglas.

Rheem literally lines these new tanks with glass. It is sprayed on in the form of a slip, made from a special frit and is later fused with the metal walls of the tank at 1600° F.



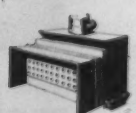
Over-all view of automatic machines.

To produce these superior tanks in quantity and at reasonable manufacturing costs, Rheem engineers rely heavily on the latest techniques of mass production. Equipment was developed, with the help of Binks engineers, to apply the glass linings automatically.

A long reciprocating arm pushes Binks Model 21V automatic spray guns deep into the tank. The guns turn on and off automatically and coat the inside of the tank quickly and uniformly. Flues are coated separately on Binks vertical reciprocating machines.

Installations of this kind show what can be accomplished when plant engineers utilize the knowledge and experience of specialists. Binks engineers have worked closely with leading manufacturers for over 50 years. The knowledge they have gained is yours for the asking.

Binks
EVERYTHING FOR SPRAY PAINTING



SPRAY BOOTHS

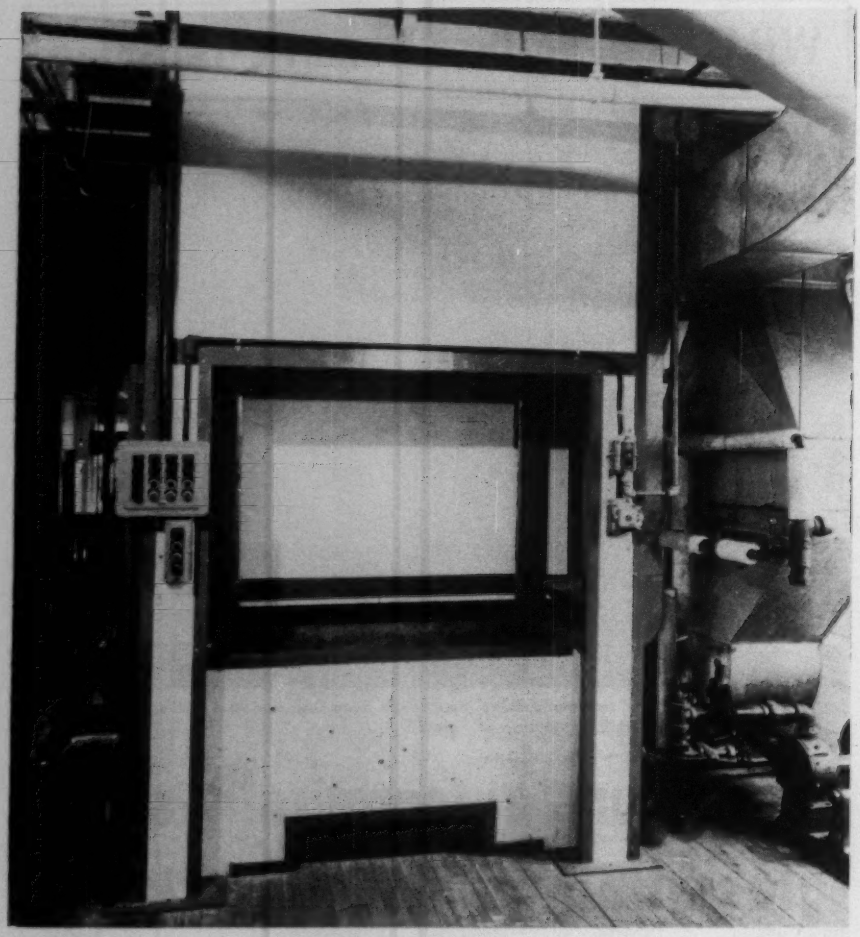
COMPRESSORS

FREE INSTRUCTION

Binks Manufacturing Company
3132-40 Carroll Ave., Chicago 12, Illinois

128-55

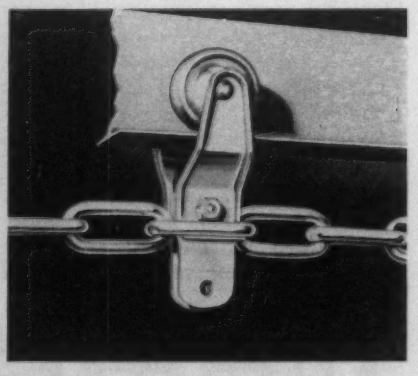
REPRESENTATIVES IN PRINCIPAL U. S. & CANADIAN CITIES · SEE YOUR CLASSIFIED DIRECTORY



DIP COATING AND DRYING EQUIPMENT

Two-dip system is designed for the application and drying of a primer and finish coat to small parts at a high production rate. Equipment produces a coating of uniform thickness that is drain free and tear free, and dries it in an atmosphere independent of ambient humidity and temperature. Automatically controlled extraction angles and extraction speeds, and drying in a forced draft controlled atmosphere are features of the equipment. Dip coating technique can be used for the application of protective or decorative coatings of lacquers, enamels, paints or varnishes, as well as various types of plastic coatings. Unit is 13 feet high; floor space required is 10 by 28 feet. Special chain attachments permit one operator to load and unload work carrying racks on the internal dual chain conveyor. Lift doors allow access to removable dip tanks. Recirculation of coating materials in the tanks provides proper dispersion of pigments. Overflow drains which are part of the recirculation system assure maintenance of constant level and removal of trapped air. **Applied Engineering Associates,** 1952 Flushing Ave., Brooklyn 37, N. Y.

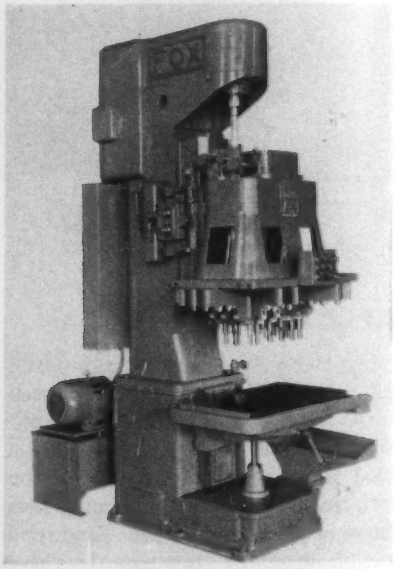
Circle No. **12** *on Reply Card*



TROLLEY CONVEYOR

Overhead trolley conveyor is suited to inter- or intradepartmental handling and storage of parts during manufacturing or processing, or for moving and storing any load of average weight suitable for overhead handling. Conveyor is available for either welded or bolted assembly. Trolleys are normally spaced on 8, 12, 16 or 20-inch centers, and can be easily moved from one space to another by removal of a single bolt, without disturbing turn or drive sprockets. Two capacities of trolleys are available; a 40-lb capacity trolley with single race bearing wheels, and an 80-lb capacity trolley with double-race bearing wheels. Heavier loads are accommodated by installation of load bars between trolleys. Ultimate strength of the chain is 6000 lb, with a yield point of 4000 lb. In operation, chain pull is limited to 600 lb to provide long chain life. Speed range is 0.8 to 60 feet per minute. **Alvey-Ferguson Co.,** Cincinnati 9, O.

Circle No. **13** *on Reply Card*

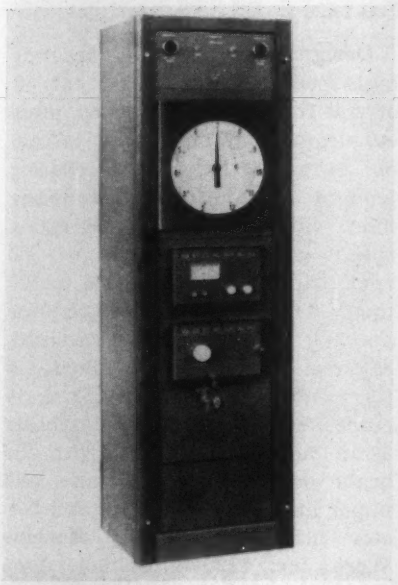


DRILLER AND TAPPER

Vertical multiple-spindle hydraulic-feed drilling and individual lead screw feed tapping machine has 12 by 24-inch adjustable spindle head equipped with 16 spindle pinions for 1⅜-inch universal joints. The head and slide are hydraulically counterbalanced. Spindle speed change, over a range from 202 to 990 rpm, is by pickoff gears located on top of the head. Both drill and tap cycles are automatic, initiated when the operator depresses the "cycle start" push button. Drill cycle is rapid advance,

coarse feed, fine feed, dwell at reversal point, and rapid return. Tap cycle is rapid advance to a positive stop. Then tap spindles start to feed taps at lead screw rate, tap spindles reverse to retract taps and return spindles to their retracted position where they brake to a stop. Head returns at rapid return rate to normal up position. Rapid advance and return rates are 158 and 183 inches per minute respectively. Drilling feed, variable within limits of the two ranges, is 0.7 to 18 inches per minute in the coarse feed range, 0.5 to 6 inches per minute in the fine feed range. Design thrust at 1000 psi is 5.7 tons. **Fox Engineering Co.**, 1336 Francis St., Jackson, Mich.

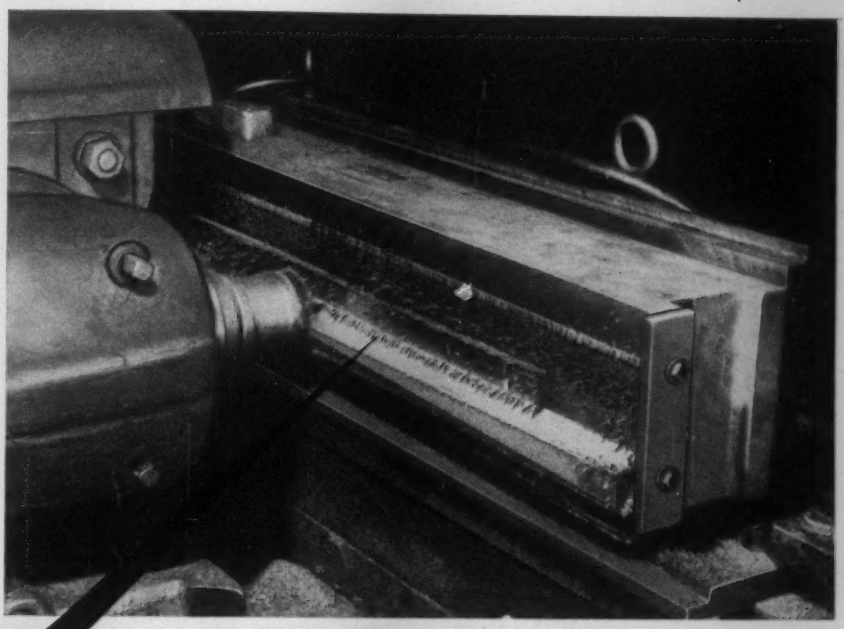
Circle No. **14** *on Reply Card*



PACKAGED pH SYSTEM

Designed for use in any pH process application, new system combines in one package all the components needed for single or multiple channel pH process monitoring, recording and controlling. Basic components of the system can be assembled into different combinations varying from the simple combination of pH meter and alarm to the multiple channel monitor-recorder-alarm control system. Unit is available wired, piped and assembled, ready for installation. **Beckman Div., Beckman Instruments Inc.**, Fullerton 1, Calif.

Circle No. **15** *on Reply Card*



Magna-Lock Magnetic Chuck
at Turchan Follower Machine Company

REDUCES SETUP TIME 66.6%

THE JOB: Milling hard cast iron gibs, 1⅜″ maximum width, variable lengths, 60° compound angle, .250″ taper per foot. Roughing cut: 1⅜″ max. width, 0.200″ depth. Finishing cut: 1⅜″ max. width, 0.050″ depth. Spindle speed: 385 RPM. Cutter: 8-flute carbide tip 3″ dia. Table speed: 15 IPM-20 IPM. Stock removal: Approximately 4 cu. in. per min. Fixture: mechanical.

THE PROBLEM:

1. Fixture setup time and handling was 60 minutes plus time required to lay out, drill and tap holes in the gibs to coincide precisely with the bolts of the fixture. Spacing varied between 9″ and 10″ at several intermediate increments.

2. The holes were not functional parts of the gibs, being used only to hold the gibs while being milled.

3. Because of the several milling operations, the gib had to be removed each time and re-bolted to the fixture.

THE SOLUTION: A Hanchett MAGNA-LOCK Magnetic Rectangular CHUCK positioned on a sine bar, the milling machine cutter spindle being swiveled to the corresponding angles.

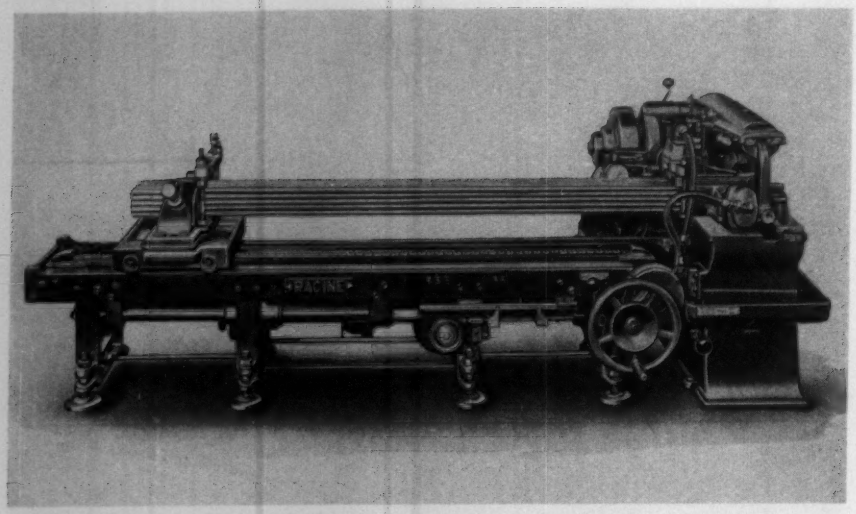
THE RESULT:

1. FIXTURE SETUP AND HANDLING TIME — 20 MINUTES.
2. Lay out, drilling and tapping operations eliminated.
3. Time required to re-bolt gibs on fixture for each operation eliminated.

You, too, can increase your machines' productivity with Hanchett Magna-Lock Magnetic Chucks and Devices. Take advantage of Magna-Lock's experience and engineering know-how — at your service to help you solve your holding problems. Magna-Lock is the only *exclusive* manufacturer of magnetic chucks and devices. WRITE TODAY, Dept. A-95.

Request Magna-Lock as original equipment on your new machines.

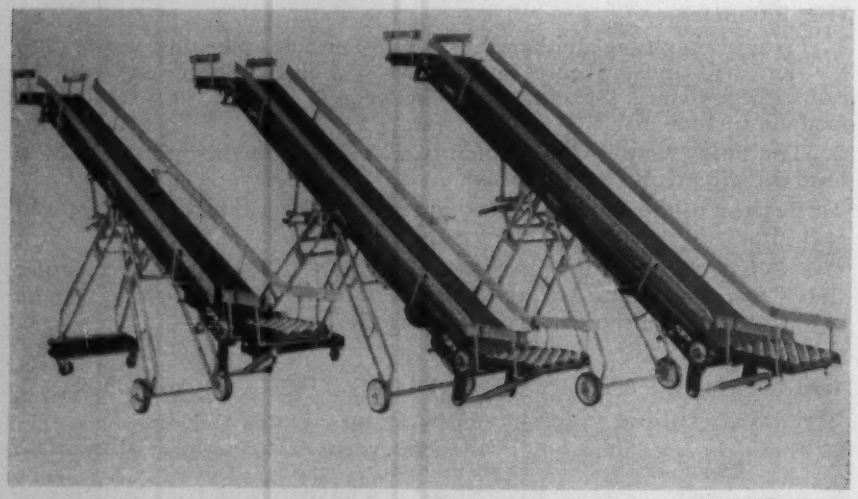
Hanchett **MAGNA-LOCK**
CORPORATION
Magnetic Chucks and Devices
BIG RAPIDS, MICHIGAN, U. S. A.



AUTOMATIC BAR FEED POWER HACK SAW

Among features of automatic stock feed machine is all front control. Operator can control all phases of automatic cycle from one position. Pointer on scale is adjustable for desired length of cut. No hand measurement or moving of stock against positive stop is required. Hydraulic feed moves solid steel section by uniformly controlled pressure from cut to cut, automatically measures stock, opens and closes hydraulic chucks, controls cutting and stops when last cut has been completed. Machine is available mounted on a turntable to cut long bars automatically at any angle up to 45 degrees. Swivel base rotates on roller bearings, stopping at any desired angle, where it can be locked in place. **Racine Hydraulics & Machinery Inc.,** Racine, Wis.

Circle No. **16** *on Reply Card*

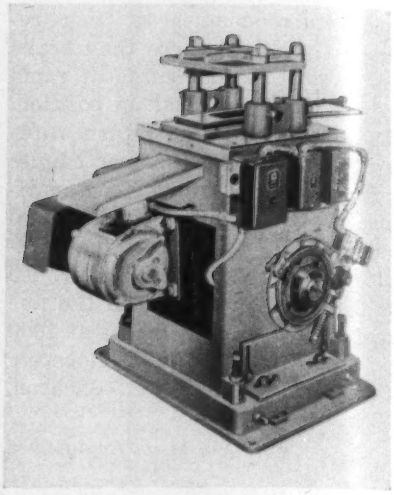


PORTABLE POWER BELT CONVEYORS

Designed for package or bag handling applications and loading or unloading boxcars, trucks or trailers, portable belt conveyors are used as a booster in a line of gravity conveyors or as a stacker in warehouse operations. Units are available in 8, 12 and 16-inch belt widths, 10, 12 and 15-ft lengths for portable incline operations, and 17½ ft and 20 ft for horizontal use.

Conveyors have ⅓, ½, ¾ and 1-hp motors. Fifteen new models in line feature box channel bed, cranking adjustable stand with antifriction bearings, wide supports and dollies, and heavy construction throughout. **Arrow Products Inc.,** 417 Front St., N.W., Grand Rapids, Mich.

Circle No. **17** *on Reply Card*



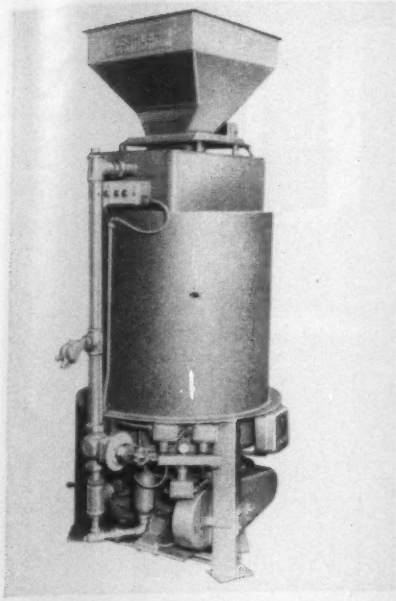
CUTOFF PRESS

Designed to provide accurate high-speed production on cut off of roll formed metal shapes, press enables use of coil stock instead of cut lengths, thus reducing amount of scrap and producing more uniform shapes. Operating speeds available are 240 or 300 rpm; capacities are from 4 to 120 tons. Among features of the press are flag trip or positive mechanical run-out table, simplified adjustment of height and lateral requirement, mechanical clutch on 4-ton units, air clutch with air brake on 8 to 120-ton units, and upper and lower die slide and bolster plate. **Dahlstrom Machine Works Inc.,** 4225 W. Belmont Ave., Chicago 41, Ill.

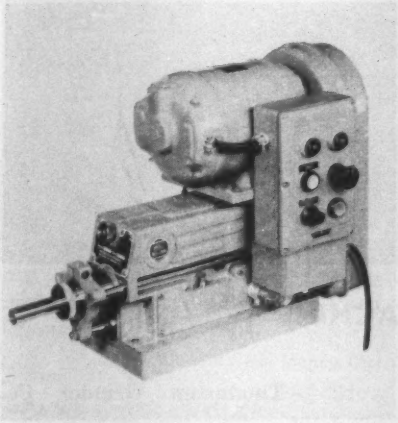
Circle No. **18** *on Reply Card*

GLUE EQUIPMENT

Glue preparation equipment automatically combines dry glue with water, maintaining a steady supply of constant viscosity glue for gluing machinery. Dry glues used in the machine need no cooking. In operation, water and dry glues are automatically fed into the machine. A dial setting adjusts the viscosity of the finished glue. As long as the setting remains the same, the viscosity remains unchanged. Capacity ranges from 5 to 40 gal per hour, depending on the characteristics of the dry glue. Machine is



used in applications such as automatic cartoning. **Potdevin Machine Co.**, 285 North St., Teterboro, N. J.
Circle No. **19** *on Reply Card*



HYDRAULIC DRILL UNIT

Designed for drilling, reaming, counterboring, spot facing and chamfering, hydraulically powered unit is completely automatic. Variable delivery hydraulic pump is an integral part of the spindle and quill. Hydraulic feeding thrust is applied directly behind the spindle, eliminating deflection and assuring smoothness of feed on heavy operations. Unit features a locked circuit feed which eliminates the constant adjusting necessary when the temperature of hydraulic oil changes. Emergency cycle return button is provided on the front of the unit and rapid traverse is controlled by limit switches on the side. Drill unit has reserve thrust

Automate for top performance with...

T-J Spacemaker CYLINDERS

CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
40% SPACE SAVED
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T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

Style SM5 shown

- The Only Cylinders with all the Extras as Standard
- OIL pressure to 750—AIR to 200 P.S.I.
- New Compact Design . . . Saves up to 40% Space
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- Hard Chrome Plated Bodies and Piston Rods (Standard)
- Only from T-J can you get these new ingenious cushion designs

OFF SHELF DELIVERY

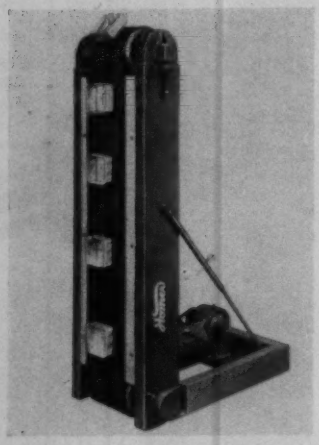
More and more of industry's automation problems today—solved with T-J Spacemaker Cylinders! New compact design and many more plus features for a new high in efficient cylinder performance and dependability. Wide range of styles, capacities . . . to help you *save labor, reduce costs* on all kinds of push-pull-lift jobs. Send for bulletin SM-155-1. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVETORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHERS

Member of the National Fluid Power Association

at all spindle speeds, variable rates of traverse, positive depth control, thrust control, and variable feed rate. Spindle drives may be V-belt pulley, direct motor, gear reduction or transmission. It is available in standard feed cycles, jump gap and dwell, and can be supplied with a time delay at the end of the feeding stroke for accurate facing-to-depth operations. It drills up to 7/8-inch diameter in steel and larger in certain other types of metals, castings and forgings. Special units are engineered and built for deep hole drilling, chip breaking, and steel parts drilling up to 35C Rockwell hardness. Unit has a depth control of 0.0005 and a maximum stroke of 5 inches; its thrust reserve can be as much as five times the requirement. **Drillmation Co.**, 21509 John Rd., Hazel Park, Mich.

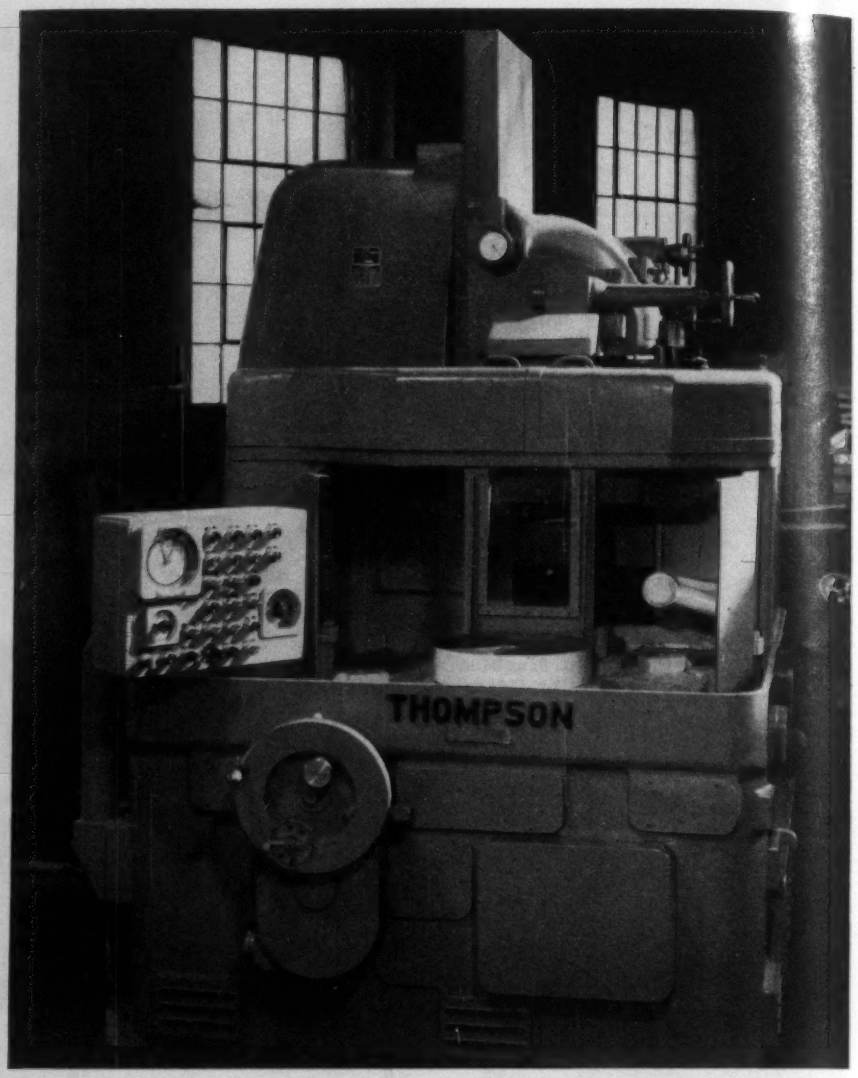
Circle No. 20 on Reply Card



MAGNETIC CONVEYORS

Designed to convey ferrous pieces and parts such as nuts, bolts, nails, washers, tin cans, bottle caps and stampings up inclines as steep as 90 degrees, magnetic conveyors eliminate long conventional conveyors with gradual inclines. As a result, production machines can be placed closer together, making floor space available for extra capacity. Conveyors will also remove scrap from receiving pits, stack flat ferrous pieces, feed machines and perform other handling operations. Conveying speeds can be planned so that material transfer between machines may be synchronized for automatic operation. **Homer Mfg. Co. Inc.**, Dept. 286, Lima, O.

Circle No. 21 on Reply Card



TWIN ROTARY GRINDING MACHINE

New machine is equipped with two rotary magnetic chucks or two rotary fixtures. In operation, as one chuck is grinding in the rear position, operator loads the opposite chuck in the front position. When the machine completes its grinding cycle, the operator depresses a button, the tables index 180 degrees and the grinding cycle starts.

The operator then unloads the part and installs a new part to complete the cycle. Complete automatic dressing and wheel compensation are used. Automatic gaging devices can be applied to the machine to eliminate separate gaging of parts from the machine. Machines are built in 6, 8, 12, 16, 20, and 24-inch diameters for rotary fixtures or chucks, and are adaptable for high production work. **Thompson Grinder Co.**, Springfield, O.

Circle No. 22 on Reply Card

INTERVAL GENERATOR

a multiple-sequence megacycle preset instrument has been designed for use in multiple-sequence control of high speed camera systems and for radiographic units used in firing ranges and destructive testing facilities. **Potter Instrument Co.**, 115 Cutter Mill Rd., Great Neck, N. Y.

Circle No. 23 on Reply Card

SWITCHING UNIT

which employs a permanently mounted flexible assembly of split rollers mounted in individual frames and moving on a stationary bed, is designed to speed and sim-

plify order spotting on the loading dock. **Metzgar Conveyor Co.**, 408 Douglas St. N. W., Grand Rapids 4, Mich.

Circle No. 24 on Reply Card

ROLL MARKING MACHINE

which is powered by air and operated by electrical remote control for hand, foot, or fixture actuation is designed to indent numbers, letters or designs on all types of metallic or nonmetallic surfaces whether round, flat or irregular, produces up to 6000 impressions per hour. **Defiance Machine & Tool Co.**, 1920 S. Vandeventer Ave., St. Louis 10, Mo.

Circle No. 25 on Reply Card

TRANSFER MACHINE

with dial-type hydraulic feed and multiple-spindles is designed to drill, ream, spotface and burr steel forged automobile front wheel spindles at 264 workpieces per hour. **Buhr Machine Tool Co.**, Ann Arbor, Mich.

Circle No. 26 on Reply Card

OSCILLOGRAPH

contains electrically controlled chart drive system which permits instantaneous speed selection in 16 variations from 1 cm per hour to 250 mm per second in new oscillograph for 4 or 6-channel recording. **Equipment Dept. RT-1, Brush Electronics Co.**, 3405 Perkins Ave., Cleveland 14, O.

Circle No. 27 on Reply Card

HEAVY DIE HANDLER

truck is designed with capacity of 4000 lb, maximum telescopic lift of 93½-inches, and triple rows of rollers in the platform. Winch operates twin hooks to pull dies on or off roller platform. **Yale & Towne Mfg. Co.**, 11000 Roosevelt Blvd., Philadelphia 15, Pa.

Circle No. 28 on Reply Card

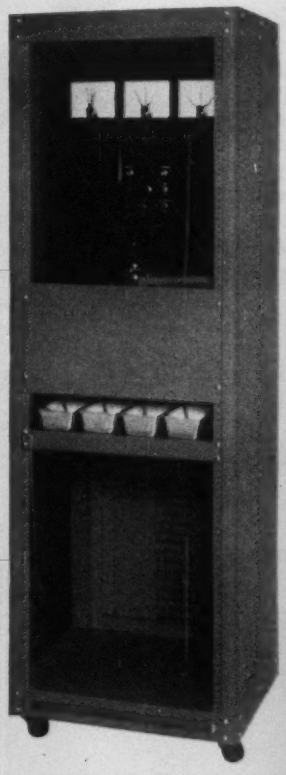
WIRING KIT

which includes an assortment of wire joint connectors, installing tool, pressure terminals and pigtails, provides fittings for a wide range of uses for plant electricians and electrical contractors. **Thomas & Betts Co.**, Butler St., Elizabeth, N. J.

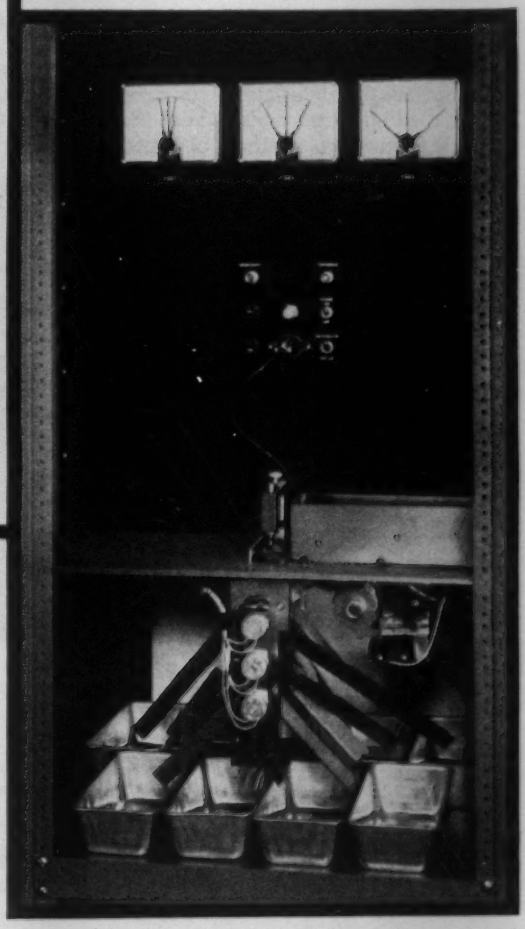
Circle No. 29 on Reply Card

NEW!

Cleveland AUTOSORT Model 101



● For automatic gaging and sorting of parts up to 3″ length and ¾″ OD at speeds of 3,000 per hour or faster



CHECKS length, OD, thickness, or any other external dimension.

SORTS into as many as 5 specific size categories plus oversize and undersize — within any range from .0002″ to .010″ as ordered — by increments as small as .000050″, depending on the range.

ADAPTABLE. Furnished to meet individual requirements as to size and shape of work, dimension measured, and number of size categories — and to accommodate any desired means for loading and discharge.

FREE BULLETIN 551 gives details. May we send you a copy? Write —

CLEVELAND INSTRUMENT COMPANY

735-6 CARNEGIE AVE. • CLEVELAND 15, OHIO

Cleveland | ELECTRONIC GAGING EQUIPMENT

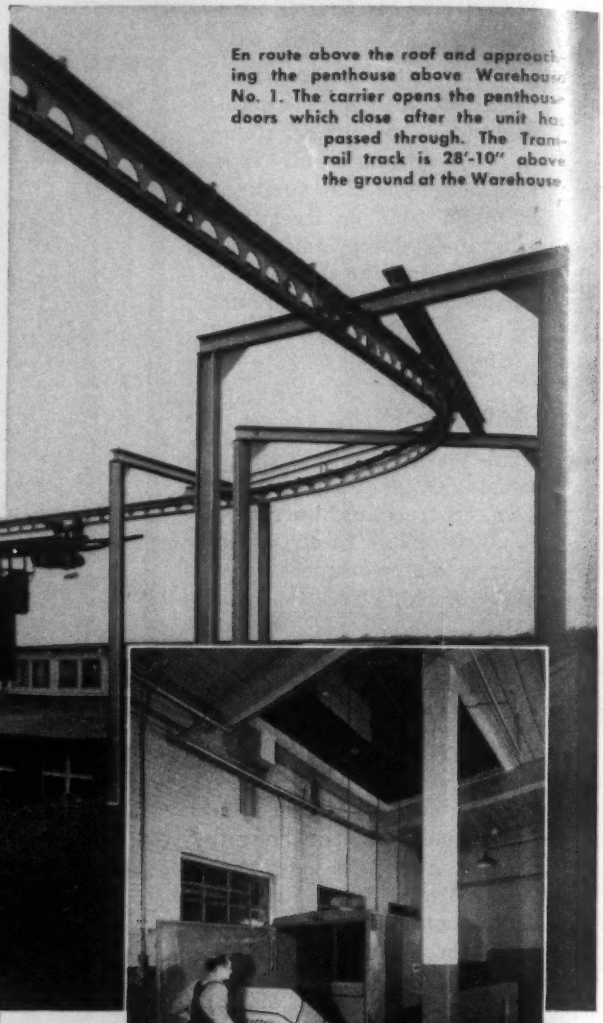
Uses Roof To Link Distant Departments

Automatic Tramrail System Saves "240 Man-Hours" Per Week

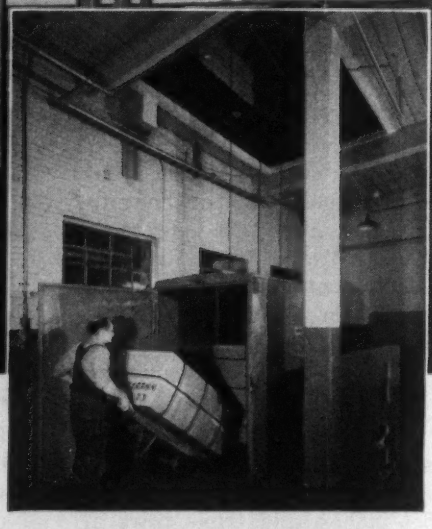
By installing a Cleveland Tramrail automatic dispatch system that extends partly over roof tops and partly between buildings, the North Carolina Finishing Co., Salisbury, N. C., was able to successfully link two widely separated departments and secure the same advantages that would be obtained if they were adjacent to each other.

This system has been in operation since 1949. It is an excellent example of the application of a bit of imagination to overcome an awkward and costly materials handling situation. It reduces the time for movement of packaged rayon cloth from the Packing Department to the No. 1 Warehouse by 240 man-hours per week.

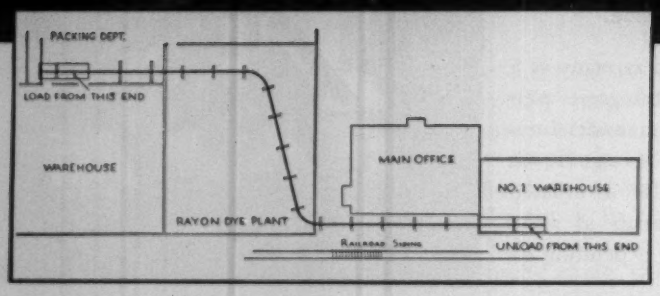
A wide variety of Cleveland Tramrail automatic dispatch systems is now serving industry. For real savings we suggest that you get the facts on this modern method of handling materials.



En route above the roof and approaching the penthouse above Warehouse No. 1. The carrier opens the penthouse doors which close after the unit has passed through. The Tramrail track is 28'-10" above the ground at the Warehouse.



6 to 8 cartons weighing 100 to 400 lbs. each are loaded into the Tramrail freight van. The button on wall, at left, sends the van on its way, first upward through ceiling opening, and then forward on outside roof track. The van measures 4'-0" x 8'-0" x 6'-6" high.



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CLEVELAND TRAMRAIL DIVISION
THE CLEVELAND CRANE & ENGINEERING CO.
1305 East 290 Street, Wickliffe, Ohio

CLEVELAND TRAMRAIL
OVERHEAD MATERIALS HANDLING EQUIPMENT

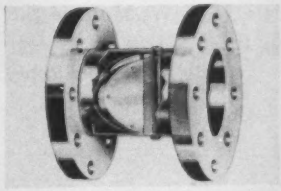
AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

Automatic Gear Gage

Designed to ensure automatic control of single-spindle and multi-spindle type hobbing machines, automatic gear gage sorts gears according to production tolerance limits and permits control of the hobbing machine to prevent production of scrap and reduce the cost of making gears. Each gear gage is custom designed for customer requirement. Sorting gears according to tolerances established by the user, gage is capable of handling as many as 1000 gears per hour. Automatic indicators signal when the pitch diameter falls outside allowable limits, also indicating when the hob has begun to dull. An automatic circuit removes power from the hobbing machine if it produces too many gears outside the tolerance limits. When used with a suitably equipped hobbing machine, gage automatically controls the machine for both pitch diameter and for hob shift to compensate for hob wear. Gear gage consists of two separate units and an interconnecting cable. One unit mounts on a frame or pedestal adjacent to the hobbing machine. Hobbed gears are delivered to this unit either by an automatic chute or conveyor from the hobbing machine or by hand. After checking, each gear leaves the gage through one of three chutes—acceptable, salvageable or unsalvageable—suitable for feeding conveyors, storage bins, etc. Second unit mounts vertically on a post or panel in any available location. **Airborne Instruments Laboratory Inc.**, Mineola, N. Y.

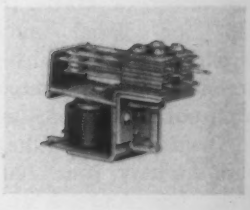
Circle No. **30** *on Reply Card*



Check Valve

New check valve operates in high or low pressure gas, water, vapor, gasoline and other fluid lines, giving positive automatic opening and closing on low pressure differential. Valve can also be used in other applications, such as antisurge and nonreturn operations. Valve does not use a valve seat; it employs body of valve for that purpose, permitting unrestricted straight line flow and silent operation. When flow reverses, valve elements expand against valve wall, effecting a seal against reverse flow. Check valve is available for pressures up to 50 psi and 200F. Made in range of materials including steel, bronze, cast iron, aluminum, stainless steel and other alloys. **Techno Corp.**, 16-30 W. 5th St., Erie, Pa.

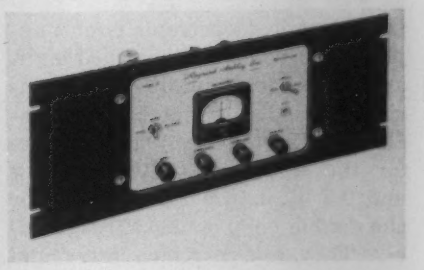
Circle No. **31** *on Reply Card*



Motor Controller Relay

Alternating current magnetic motor controller relay is available in any standard arrangement of contact combinations from single pole, single throw, normally open, to double pole, double throw. Coil voltage of the units is 115v, 60 cycles. Contacts are rated at 115v ac, 60 cycles, single phase, ¼-hp. Standard coil and contact terminals are lug type, tinned for easy soldering. Bakelite insulation of the contacts is tested at 1500v, 60 cycles. The standard double pole, double throw unit weighs 4.3 oz. **Guardian Electric Mfg. Co.**, 1621 W. Walnut St., Chicago 12, Ill.

Circle No. **32** *on Reply Card*

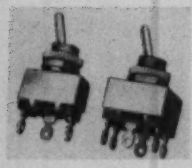


Eight-Tube Servoamplifier

Designed to drive pneumatic or hydraulic servovalves in power servo applications, eight-tube servoamplifier features good dynamic response, a variable frequency dither oscillator, a 4 kc oscillator to excite variable reluctance

or E type transformer pickoffs, and provision for plug-in compensating networks to alter servosystem dynamic response where required. Servoamplifier produces a dc differential current proportional to a dc input signal in the push-pull output stage. Current operates at a high impedance level to minimize inductance lags from the coils in the servovalve electromechanical actuator. A variable frequency dither oscillator (100 to 400 cps) supplies a signal superimposed on the control signal to reduce the effect of static friction. Designed for panel mounting, servoamplifier indicates either output current level or system balance, with output current level adjustable from 8 to 20 milliampere. **Raymond Atchley Inc.**, 12012 W. Pico Blvd., Los Angeles 64, Calif.

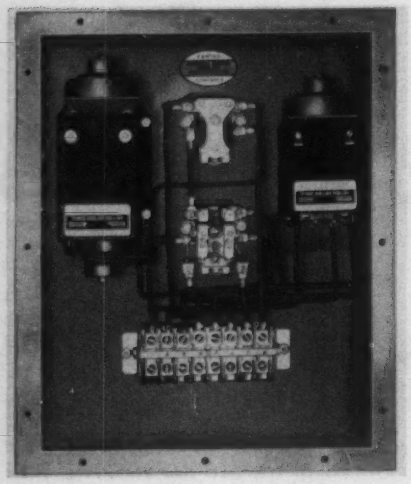
Circle No. **33** *on Reply Card*



Subminiature Toggle Switches

New toggle switches are 50 per cent smaller in size and weight than previous models manufactured by the company. Both are double throw, and are available in single pole and double pole models. Switches are contact rated for 10 amp at 50v dc, and weigh 0.15-oz and 0.22-oz respectively. They are available for commercial as well as aircraft and other military electrical-electronic circuit applications where savings in weight and space are important. Dimensions, including terminals and handle are 0.25 by 0.5 by 1.047 inches for the single pole, double throw and 0.5 by 0.5 by 1.047 inches for the double pole, double throw model. They are corrosion proof and will operate in the temperature range of −55C to 85C. Contact resistance is less than 0.003-ohm; insulation resistance is over 100,000 megohm at 100v dc and 70F. Switches are single hole mounted; one piece housings are of aluminum bronze alloy. **The Torsion Balance Co.**, Clifton, N. J.

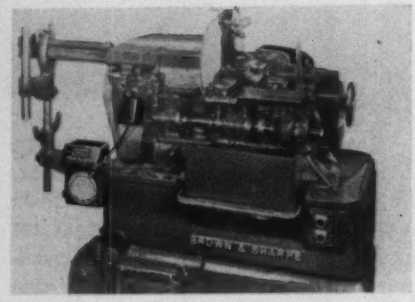
Circle No. **34** *on Reply Card*



Control Panel

Automatic control circuit is designed to prevent battery and starter damage due to over-cranking. Circuit is housed in a dust proof panel box. Control panel is designed for use in sequence operations, textile machines, process equipment, printing press equipment, load transfer, microwave equipment, machine tools, warning panels, fuel flame control and superheaters. **Industrial Control Panel Co.**, 517 W. Monroe St., Chicago 6, Ill.

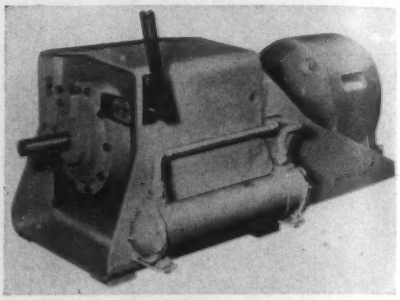
Circle No. **35** *on Reply Card*



Semiautomatic Control Unit

Designed for Brown & Sharpe machines, semiautomatic control unit called Count-O-Larm keeps a count of parts produced, but never counts a part that does not measure up to the specified length. It also eliminates practice of having machines run without stock by giving simultaneous visual and audible alarms whenever the bar in the machine is exhausted. Count-O-Larm sounds a buzzer and illuminates a red light when the machines are out of stock. Basic part of the system is a revolving stop equipped with built-in switches and mounted in the machine's turret. This stop picks up current from the machine and transmits it to a feed drum switch box which activates the precision geared counter. Machines that use a revolving shaft through the turret or have all turret holes filled with cutting tools can be equipped with a swing stop incorporating built in switches. If the collet sticks and refuses to open, or if the feed finger becomes loose, the stock will not be fed out to its full length, and the Count-O-Larm will sound its warning and stop the counter. **Count-O-Larm Co.**, 1271 W. North Ave., Chicago 22, Ill.

Circle No. **36** *on Reply Card*

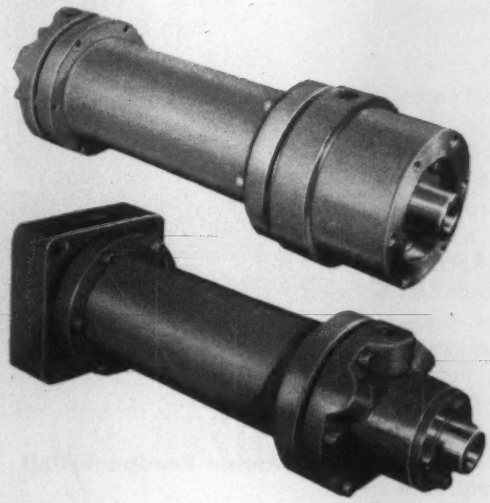


Self-Contained Fluid Drives

Stepless speed control, no-load starting and good torque limiting control for smooth transmission of power in power plants, refineries, steel mills and a variety of other general industrial applications are the features of line of self-contained fluid drives. Units are available for a wide range of speed adjustment on both variable and constant torque loads. Fluid drive and load can be reversed while in motion by reversing input rotation when used with an electric motor. Units will limit the amount of overload torque which can be transmitted to the load. Torque transmitting capacity is adjusted by positioning the speed control lever. Rate of movement of the same lever governs acceleration rate. Fluid drive is adaptable to manual or fully automatic control. Unit is available in six sizes from 7½ to 800 hp for operating speeds up to 1800 rpm. Welded steel housing serves as an oil reservoir as well as an enclosure for the rotors, bearings, oil circulating pump

ANNOUNCEMENT!

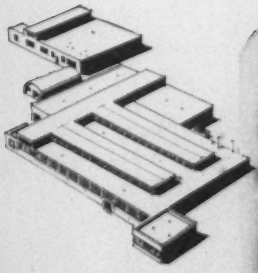
Teer-Wickwire, manufacturer of precision parts, takes over Lindberg cylinder line



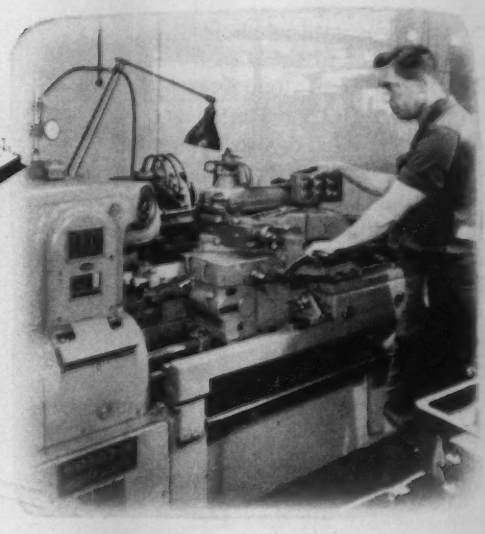
Now Lindberg Air and Hydraulic Division of Lindberg Engineering is Lindberg Air and Hydraulic Division of Teer-Wickwire & Co. Operations have been moved from Chicago to Jackson, Michigan, into a new plant devoted to cylinder manufacture.

Out of this modern 60,000 square foot plant at Jackson will come the present line of Lindberg air and hydraulic cylinders, manufactured to new standards of quality, durability and performance. In development now, and due for release soon, are revolutionary new cylinders to meet tomorrow's requirements with less bulk, less weight, less cost.

WHO IS TEER-WICKWIRE & CO.?



We are specialists in mass production of precision parts and components at low cost. We have been a contract manufacturer for the automotive industry for 25 years. We are *exclusive* suppliers of several components for some of the largest makers. Our plants are tooled with the latest machines. We combine proven production methods with rigid quality control systems to achieve high quality at competitive costs. *All of this experience now goes to work for users of air and hydraulic cylinders!*

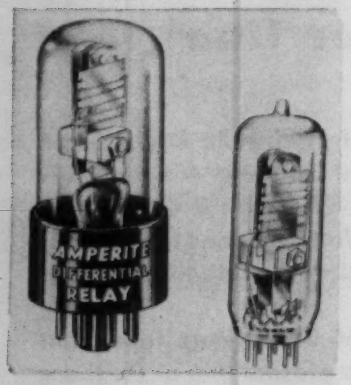


The Monarch Tracer-type lathe pictured is typical of the modern machine tools used in our plant.

LINDBERG AIR AND HYDRAULIC DIVISION
TEER-WICKWIRE & COMPANY
Jackson, Michigan

and speed regulating scoop tubes. Turbine type regenerative oil circulating pump, consisting of multiple rotors mounted on the input shaft, delivers a constant volume of oil for the working circuit and for lubrication regardless of output speed. Oil coolers are required with all adjustable fluid drives. **American Blower Corp.**, Detroit 32, Mich.

Circle No. **37** *on Reply Card*



Differential Relays

Used for automatic overload, over voltage, under voltage or under current protection, differential relays reset automatically when the abnormal condition is removed. Since actuating element is a heater, relay may be designed for time constants varying from approximately 3 to 30 seconds. It will not respond to transients of shorter duration. Relays can be designed for currents from 10 to 1000 ma, voltages from 1 to 100 v. Higher currents can be handled by external contactor. Differential relay is available in either standard octal base or nine-pin miniature. Standard tolerance of voltage or current for opening and closing is ±10 per cent. **Amperite Co.**, 561 Broadway, New York 12, N. Y.

Circle No. **38** *on Reply Card*

Aerator Unit

New device introduces small volumes of low pressure air into dry, finely ground materials stored in bins, hoppers and silos. Most materials of this type, such as cement, flour, fertilizer, pigment, etc., contain enough air to assure free flowing when they are placed in the bin. However, the material loses this air as it settles and often

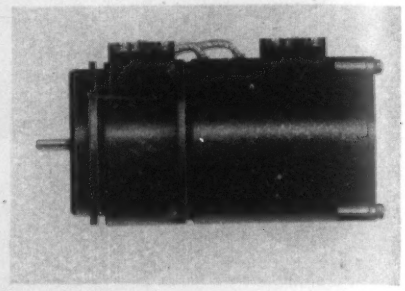
packs and refuses to flow when material movement is desired. Air introduced into the material through the aerator unit replaces that lost by the settling action and restores free flowing characteristics, permitting material to discharge freely from bin, hopper, or chute by gravity. Low pressure air (1 to 5 lb) is introduced into the unit through a pipe nipple which also acts as an orifice controlling the volume of air. It is distributed throughout the air chamber of the unit by a baffle. Air is introduced into the material through a nonclogging fabric diffuser. Aerator units are available for installation in thick or thin walled bins, silos, hoppers and chutes. Special units are available for use with hot or corrosive materials. **Bin-Dicator Co.**, 13946-209 Kercheval, Detroit 15, Mich.

Circle No. **39** *on Reply Card*

Motor Control Center

Construction of motor control center permits assembly of control devices required by customer, such as individual controllers, disconnect switches and accessories, in enclosed, sectionalized unit. Control centers are available either with all wiring busses, supports, terminals and interconnections already made, or with provisions for wiring on the job. Among control devices available for mounting in control center are three-pole fusible disconnect switches and combination starters, three-pole circuit breakers and combination starters, pushbuttons, indicating lights, interlocks, control relays, lighting transformers, etc. Center can be moved as a complete unit without changing internal wiring. **Cutler-Hammer Inc.**, 315 N. 12th St., Milwaukee 1, Wis.

Circle No. **40** *on Reply Card*



Tachometer Feedback Unit

Combination servomotor and ac tachometer generator which operates on 60 cycles is designed for industrial applications. Units, which have motor and tachometer generator mounted on a single shaft, can be used to regulate speed of a motor or to stabilize closed-loop circuits. Available with five different gear reduction ratios, unit is suitable either as a differentiating or integrating component of analog computers, or as a component of recording and controlling instruments. Ratios are 191.1 to 1, 76.6 to 1, 32.4 to 1, 13.8 to 1, and 5.8 to 1. Adjustments are made by loosening four screws, then adjusting the core. Among features of unit are availability of high impedance control phase windings for plate-to-plate operations, and 57½/57½v control phase windings for magnetic amplifier applications. Motor tachometer unit is available with motor ratings of either 1, 5, or 10w output. **Diehl Mfg. Co.**, Finderme Plant, Somerville, N. J.

Circle No. **41** *on Reply Card*

THIS DIFFERENT 4-WAY VALVE

offers the simplest approach to

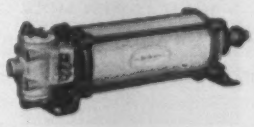
AIR DESIGN PROBLEMS

FIRST It is compact. It fits well in tight quarters. While electrically actuated it takes but a fraction of the space required by double acting power solenoids. Yet it is a complete valve within itself, with built-in dual speed controls as well as directional valve control.

SECOND It is safe—safe for operator, safe for machine. Operating on low voltage (8 volts) it is free from electrical hazard, and electrical hook-ups can be made without conduit or heavy insulation.

THIRD It is rugged and durable. Operating records of 30, 40, 50 million or more cycles without maintenance expense are quite common. In fact, we guarantee the solenoid controls against burnout.

FOURTH It is fast. Faster than the speed of even present-day short stroke air cylinders.



The Bellows Electro-aire Valve is made in ¼", ⅜" and ½" port sizes. It can be adapted for direct connection to, or remote control of any air cylinder. It is a built-in feature of all Bellows Air Motors and "Controlled-Air-Power" Devices arranged for electrical control.

1221-A

Write for Bulletin AV-300R
Address: The Bellows Co., Akron 9, Ohio
In Canada: Bellows Pneumatic Devices of Canada, Ltd., Toronto
Dept. AU955

The Bellows Co.
AKRON 9, OHIO

transistor and
digital computer techniques

APPLIED TO THE DESIGN, DEVELOPMENT
AND APPLICATION OF

AUTOMATIC RADAR DATA PROCESSING,
TRANSMISSION AND CORRELATION
IN LARGE GROUND NETWORKS

Engineers
&
Physicists

Digital computers similar to successful Hughes airborne fire control computers are being applied by the Ground Systems Department to the information processing and computing functions of large ground radar weapons control systems.

The application of digital and transistor techniques to the problems of large ground radar networks has created new positions at all levels in the Ground Systems Department. Engineers and physicists with experience in the fields listed, or with exceptional ability, are invited to consider joining us.

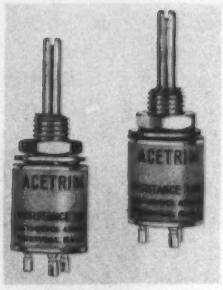
FIELDS INCLUDE

TRANSISTOR CIRCUITS • DIGITAL COMPUTING NETS • MAGNETIC DRUM AND CORE MEMORY • LOGICAL DESIGN • PROGRAMMING • VERY HIGH POWER MODULATORS AND TRANSMITTERS • INPUT AND OUTPUT DEVICES • SPECIAL DISPLAYS • MICROWAVE CIRCUITS

Scientific and Engineering Staff

HUGHES
RESEARCH
AND DEVELOPMENT
LABORATORIES

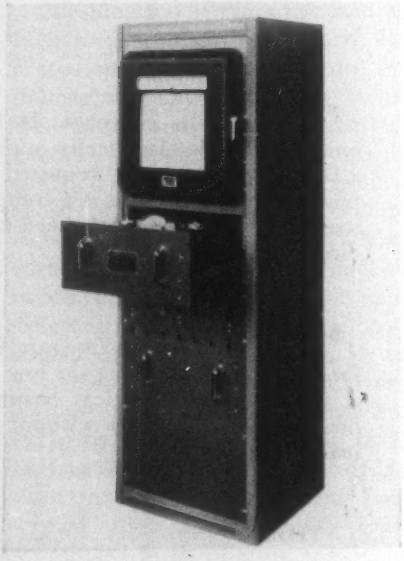
Culver City, Los Angeles County, California



Potentiometer Trimmers

Subminiature wire wound precision potentiometer trimmers have ½-inch diameter, resistance range from 10 ohm to 50k, ambient temperature range from −55 to 125C, new type shaft lock and weigh ¼-oz. Linearity is 3 per cent. Case and threaded mounting bushing are one piece anodized aluminum for maximum heat dissipation. Shaft is centerless ground stainless steel with a threaded bushing. Unit is available with nonrotating lock or stops. Units are completely sealed against sand, dust and foreign matter to avoid abrasive action between moving parts. Ace **Electronic Associates,** 125 Rogers Ave., Somerville 44, Mass.

Circle No. **42** *on Reply Card*

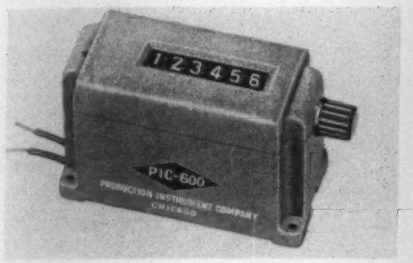


Infrared Analyzers

Four series of infrared analyzers are designed for usual types of continuous analyses of gas or liquid streams and also those involving detection of contaminants in the range of parts per billion. Analyzers are also used in solu-

tion of problems found in the petroleum and chemical processing industries. Series A are completely explosion proof; Series B are similar to Series A, except that electronics and recorder are remotely located and are not explosion proof. In Series C, detector section is connected to the electronics section by a 500 ft cable. Series D (illustrated) have all components mounted in a metal cabinet. Neither Series C or D are explosion proof. Each series is designed to solve a particular class of continuous analytical problem. **Perkin-Elmer Corp.**, Norwalk, Conn.

Circle No. **43** *on Reply Card*



Electric Counters

Medium size electric counters in basemount and panelmount models feature 50 million count life and 1000 counts per minute rating. Power consumption of the unit is 7 w. Balanced armatures are used to afford reliable operation on airborne equipment and quiet operation with no ac hum when energized. Counters have continuous duty coils and operate in any position. One-piece, die cast housing with close fitting cover held by concealed screws provides protection against dust and tampering. Wiring leads are brought out through the center of the housing bottom, giving added protection against dust for basemount models, as well as convenient wiring from either end or rear through small wiring ports in the rim of the base. Housing bottom lead exit also provides a good wiring location for panelmount models. Made in 6-digit models with white figures on black wheels, counters are available for most voltages up to 120 ac or dc. **Production Instrument Co.**, 704-26 W. Jackson Blvd., Chicago 6, Ill.

Circle No. **44** *on Reply Card*

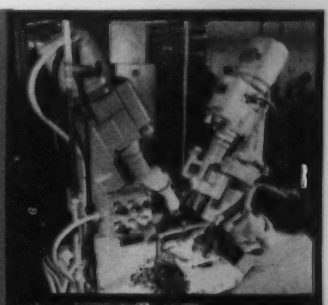
HARTFORD *Special*

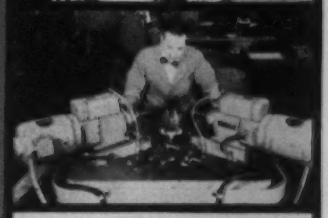
DRILL UNITS*

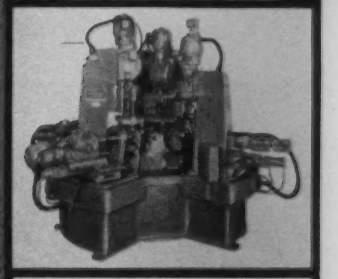
combined with our other STANDARDIZED COMPONENTS offer LOW COST AUTOMATION

on these operations:

Drill—Single and Multiple Spindle	Ream	Tap
Deep Hole Drill	Spot Face	Bore
Countersink	Center	Mill
Outside Thread	Chamfer	Face
Counterbore	Hollow Mill	Recess

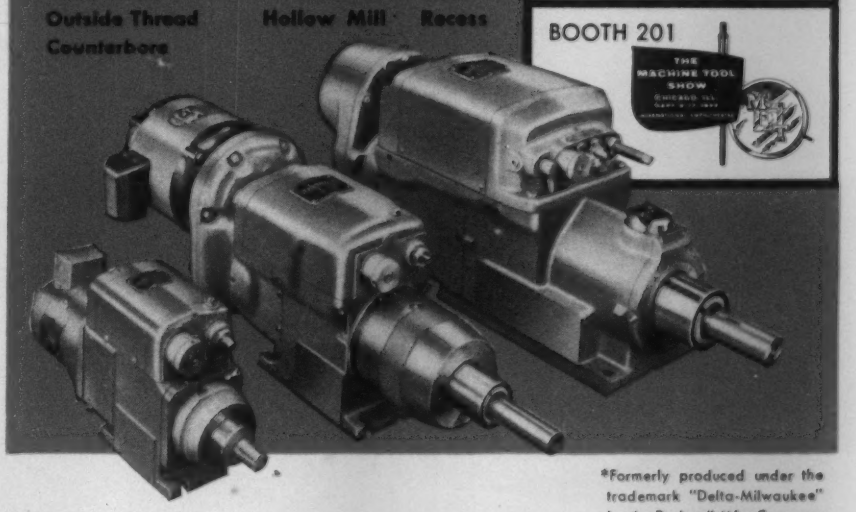






BOOTH 201

THE MACHINE TOOL SHOW



*Formerly produced under the trademark "Delta-Milwaukee" by the Rockwell Mfg. Company

Absolute depth and feed control plus high rapid traverse make "Hartford Special" Drill Units workhorses on high production jobs requiring accurate machining operations. These flexible components can be combined with other Hartford standardized components to provide low cost automation to every manufacturer through machines of his own construction. Our large staff of Sales Engineers is ready to study your processing problems and make recommendations to lower your manufacturing costs.

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MACHINE TOOL DIVISION
THE HARTFORD SPECIAL MACHINERY CO.
285 Homestead Avenue, Hartford 12, Conn. F-503-9

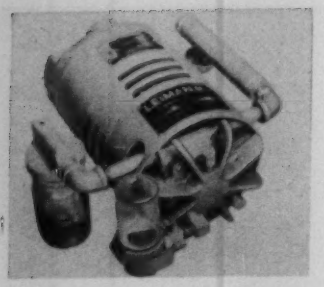
☐ Have Field Engineer call.
☐ Send Application Data Sheet and Descriptive Bulletin.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

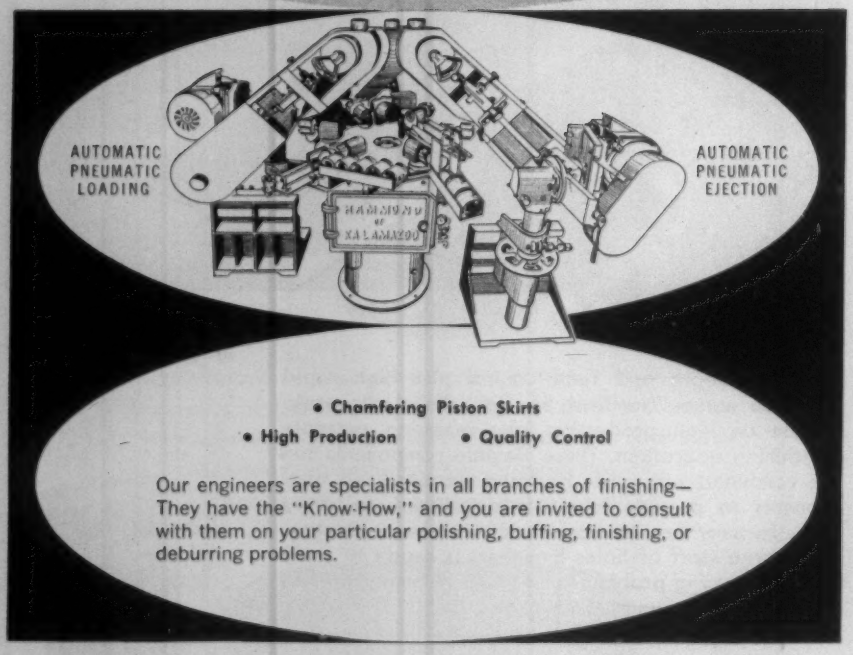


Air Pump and Motor Unit

High capacity air pump and motor provides 28-inch Hg continuous vacuum, 20 lb pressure and has 7.2 cfm displacement. Overall size of the unit is 18½ inches long by 15 inches wide by 7 inches high. Model features a ball bearing motor and rotary pump, with a cast iron housing and two steel blades with an automatic adjuster to insure constant blade to wall contact. Unit is fan cooled and mounted on rubber silencers. Motor is equipped with automatic thermal overload protection. Lubricator has an inlet filter and outlet separator to provide oil free air. **Leiman Bros. Inc.**, 102 Christie St., Newark 5, N. J.

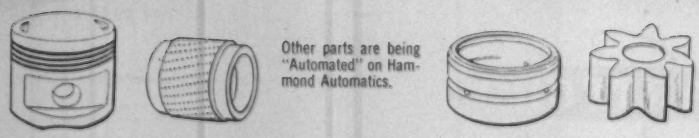
Circle No. **45** *on Reply Card*

Hammond
of KALAMAZOO
AUTOMATION



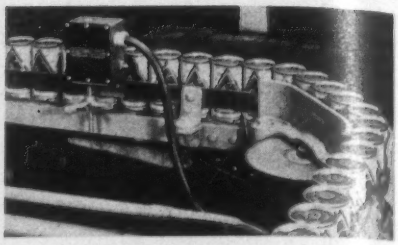
• Chamfering Piston Skirts
• High Production • Quality Control

Our engineers are specialists in all branches of finishing—They have the "Know-How," and you are invited to consult with them on your particular polishing, buffing, finishing, or deburring problems.



Other parts are being "Automated" on Hammond Automatics.

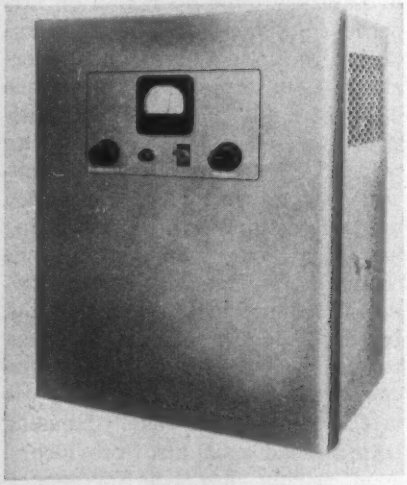
Hammond Machinery Builders Inc. 1650 Douglas Ave. • Kalamazoo, Mich.



Electric Contactor

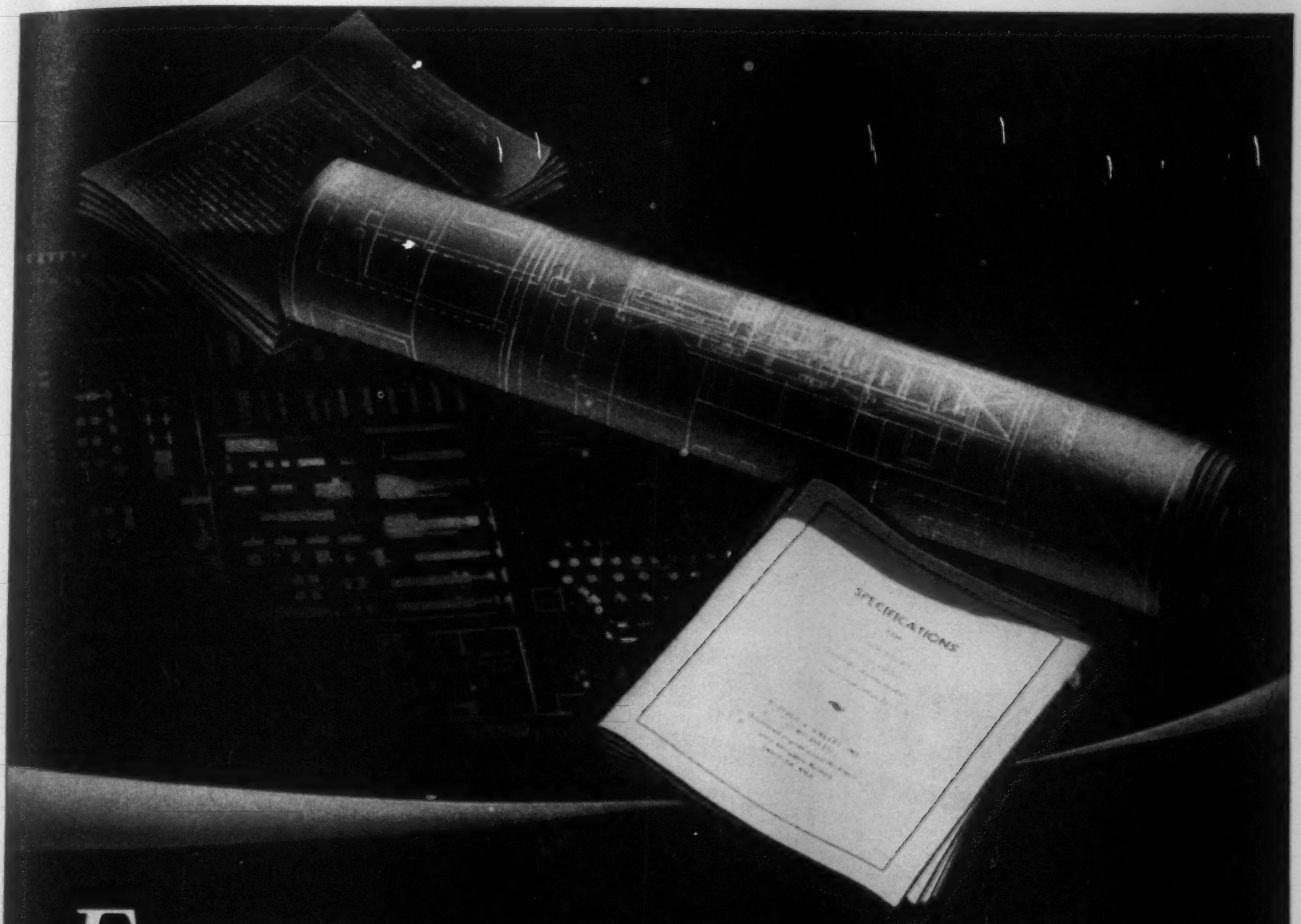
Used to actuate an electric counter, device for conveyor lines features waterproof construction. Unit is well suited for use in bottling and food packing plants, since it can be placed on a line where it will take washdown operations. Contactor with star wheel functions on conveyor line as an actuator of the electric counter to which it is connected. As many contactors and counters are used as there are lines and stations. Counters are placed in a dry, clean location in panel formation. Count of each production line is taken from the centralized panel. Production can be determined at a glance for all points in the plant, permitting accurate supervisory and production control. Unit is geared to make one count cycle for every ten items passing. **Durant Mfg. Co.**, 1997 N. Buffum St., Milwaukee 1, Wis.

Circle No. **46** *on Reply Card*



Line Voltage Regulator

Designed to control electrical energy for precision machinery, voltage regulator holds output voltage within ±½ per cent. Output voltage may be set at any voltage be-

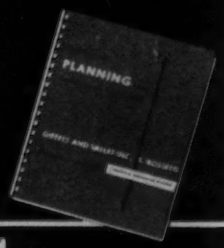


Experience is important

. . . IN PLANNING YOUR AUTOMATED PLANT

AUTOMATION has been engineered into Giffels & Vallet projects for many years. Although it was then not identified as Automation by name, it *did* produce automatic operations of many types. Automatic shakeouts in foundries—automatic stackers in board plants—automatic surge storage between machines—and many other applications throughout industry.

Automation is but one phase of the comprehensive planning and engineering services provided by Giffels & Vallet. Rubber, Plastics, Metalworking and Cement—these are but a few of the widely diversified industries Giffels & Vallet is serving. These services are discussed in a special Planning Brochure, and a copy will be mailed upon request.



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INDUSTRIAL ENGINEERING DIVISION

NEW YORK
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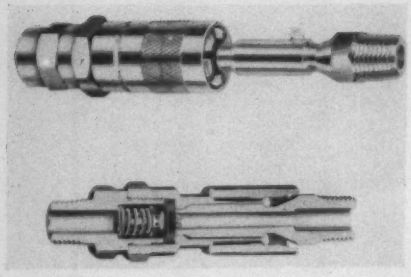
DETROIT, MICHIGAN

tween 210 and 240 for variations of the input line voltage between 195 and 280v. Regulator is designed to handle up to 8½ kva loads at output currents of 22 amp. Correction rate is approximately 20v per second. Based upon the use of a motor driven variable tranformer, line voltage regulator is unaffected by unbalanced loads and may be used for the operation of electrical equipment sensitive to line voltage changes. It will operate from a 230v three-phase source of power. **Elox Corp. of Michigan,** 740 N. Rochester Rd., Clawson, Mich.

Circle No. **47** *on Reply Card*



Quick Connect Coupling

A modified collet principle for instant locking and unlocking is used in new coupling. When engaged, the coupling is free to swivel, yet has 80 per cent of the plug shoulder in complete contact with the collet fingers. New design has been tested on pneumatic and fluid applications. Stock couplings which feature light weight, small diameter and foolproof engagement under adverse conditions are available in single valve construction with choice of various styles of threaded ends and hose attachments. Collet principle of this coupling has also been used successfully on vapor proof electrical connections, rod ends and flexible shaft applications. **R. S. Corcoran Co.,** P. O. Box 1404, Joliet, Ill.

Circle No. **48** *on Reply Card*

—or, if you prefer, let us tell you the whole story right now—the story of how you can produce more gears and better gears—more splines and better splines—in less time—at lower cost.

Gear-O-Mation* will be shown in operation at the Machine Tool Show. All units are now in production and have been production-tested.

*Trademark

MICHIGAN TOOL Company

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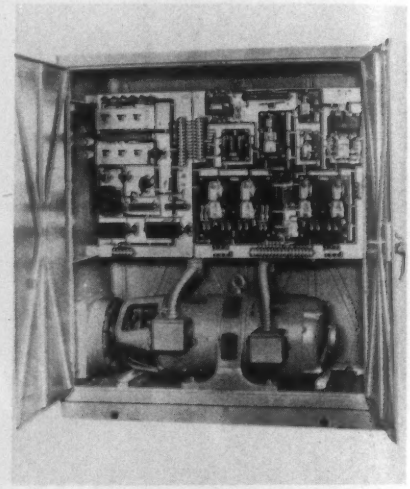
IN CANADA: COLONIAL TOOL CO., LTD.



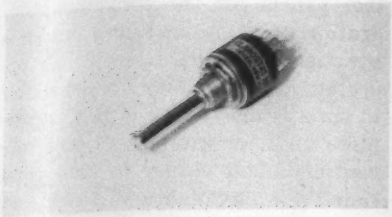
Selective Speed Drive

Four-motor selective speed unit features operations of quick start and stop. Unit has remote multimotor control, wide speed adjustment and close speed regulation. Console type control panel with visual indicators permits verification of preset operations. **Century Electric Co.,** 1806 Pine St., St. Louis, Mo.

Circle No. **49** *on Reply Card*

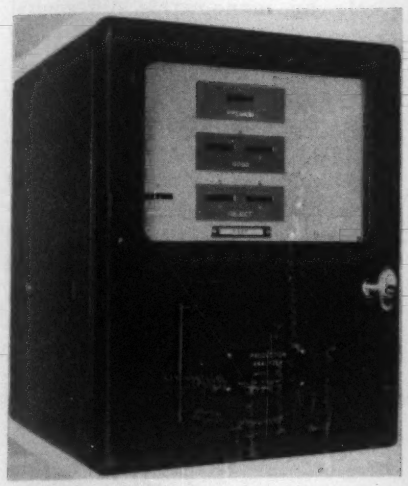
Rotary Selector Switch

New unit which performs a wide range of multiswitching operations is available in single pole (up to 12 positions), two pole (six positions), three pole (four positions) and four pole (three positions) models. Selector switch is shorting or nonshorting as required. Mounting is the same as that for the usual volume control, with ⅜-inch



bushing and ¼-inch shaft. Switch measures ¾-inch diameter by 13/16-inch overall for body and terminals. Current ratings are 50 ma at 300v ac or dc; 500 ma at 30v. **Clarostat Mfg. Co. Inc.,** Dover, N. H.

Circle No. **50** *on Reply Card*

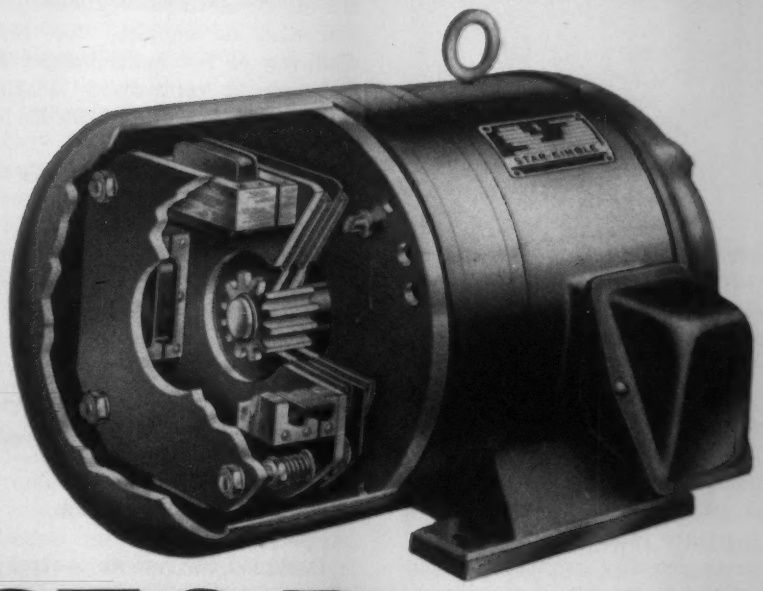


Industrial Computer

Designed to analyze the production of sheet materials, industrial computer operates with control systems. Analyzer divides total production into five weight or thickness classifications and also shows amount of production downtime. Total figures are presented by numerical counters located in the panel face which has fluorescent lighting and colored panel sections. Units of measurement are feet or yards, or multiples thereof. Analyzer, which operates over a wide range of process speeds, ties in directly with production equipment to assure accurate unit counting. Unit has applications in systems controlling steel strip, paper, rubber and plastics, but may be adapted for use with systems controlling other than sheet materials. **Industrial Nucleonics Corp.,** 1205 Chesapeake Ave., Columbus 12, O.

Circle No. **51** *on Reply Card*

START QUICKLY, SMOOTHLY, without BRAKE DRAG!



STOP FROM FULL SPEED IN A SPLIT SECOND!

WITH STAR-KIMBLE BRAKEMOTORS

Time from full speed to standstill can be as short as *one-fifth of a second* with a Star-Kimble Brakemotor — the *extra-large* brakelining area makes possible these *extra-fast* stops of motor and connected load.

Starting of the motor is fast and smooth, too. The small air gap results in instantaneous release of the brake when the motor current is switched on. No brake drag to impede acceleration.

These cycles of split-second stops and smooth starts can be repeated millions of times — that's proved by the experience of user after user of Star-Kimble motors, even in the severest types of service. In reversing service, a Brakemotor can make four times as many starts a minute as a motor which is reversed by plugging.

Every Star-Kimble Brakemotor is an integral, space-saving unit — with motor and brake designed and built together to work together. A single manufacturer — undivided responsibility.

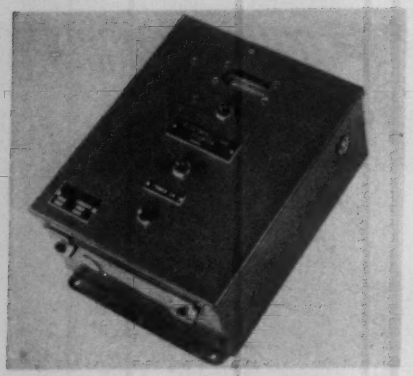
For the full story, write for Bulletin B-501-A

STAR-KIMBLE

MOTOR DIVISION OF

MIEHLE PRINTING PRESS AND MFG. CO.

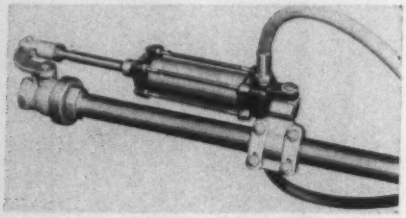
222 Bloomfield Ave. **Bloomfield, N. J.**



Electronic Load Counter

New unit counts only the load strokes of presses, shears and cut-off machines. When mounted on the side of a power press, counter produces one count on its register for each work stroke. It will not respond to strokes made without work in the dies, thus providing an accurate record of the number of parts actually produced. Electronic load counter can also be used for fatigue or cyclic tensile machines to count cycles applied to a specimen before failure. Pick-up is a pressure transducer which may be located 1000 ft from counter. Sensitivity is such that the transducer can be mounted on heavy machine sections, and still detect a stress caused by the work stroke. Counts are recorded on a six digit resettable register. Units can also be supplied for preset counting or for multichannel load counting at centralized locations. **Control Devices Inc.,** 8299 E. Nine Mile Rd., Van Dyke, Mich.

Circle No. 52 on Reply Card



Air Operated Ball Valve

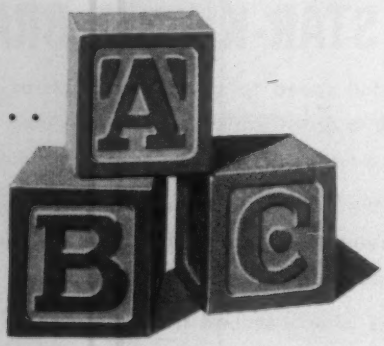
Designed for remote control use, air operated ball valve can be installed in elevated or remote locations. Valves which are installed in danger areas can be safely operated from a distance. Use of control panels for the convenient operation of many scattered valves is practical through use of air operated valve. Units are available in sizes from ⅜ to 2 inches. Complete units or kits to convert conventional ball valves to air operation are available. **Rockwood Sprinkler Co.,** 38 Harlow St., Worcester 5, Mass.

Circle No. 53 on Reply Card

Liquid Level Indicator

Designed for use with remote liquid level indicator, secondary liquid level indicator is electrically connected to a primary unit. Primary indicator is actuated directly by manometric differential pressure. Addition of a small self-contained differential transformer to primary instrument permits it to operate similarly equipped secondary instrument. Secondary indicator is actuated electronically and without any pressure connections. It may be installed at distances up to 5000 ft from primary unit and every movement of primary pointer is matched in secondary indicator.

as basic as . . .



Designed, developed and constructed for maximum versatility, MAY-FRAN conveyor components now provide users with the ultimate of flexibility. Pre-fabricated conveyor sections can be furnished rapidly and inexpensively. Sections can be assembled to form virtually any type of hinged-steel belt conveyor for handling stampings, formed metal parts, forgings, automotive scrap, chips and turnings and many other miscellaneous products.

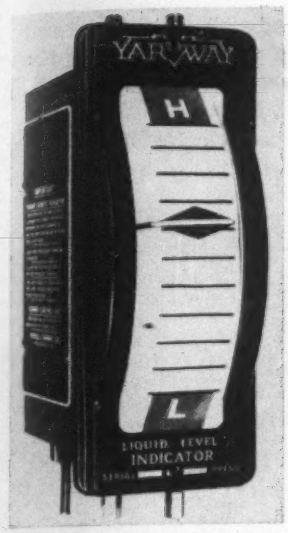
Straight sections . . . concave or convex curved

Now you can buy CUSTOMIZED conveyors in pre-fabricated STANDARD sections

MAY-FRAN ENGINEERING, INC.

4275-MF

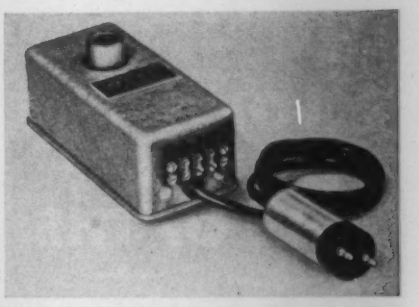
1761 Clarkstone Road • Cleveland 12, Ohio



Electronic secondary indicator is used for panel boards where fluids under pressure are undesirable. It is also used for remote locations where intervening distance from primary instrument is too great for use of pressure tubing or is subject to freezing conditions unsuitable for liquid tubing. **Yarnall-Waring Co.,** Philadelphia 18, Pa.
Circle No. **54** *on Reply Card*

Analog Conversion Unit

Designed primarily for experimental applications in a variety of measurement systems, analog conversion unit can be used in the production shop to aid in the construction of a variety of simple instrumentation systems for sampling or control of a manufacturing process, in the research laboratory to aid measurement and control, in the development laboratory to solve instrumentation problems, and in the testing laboratory to develop methods of process or product control. Unit can be used for almost any measurement of capacitance variation, and therefore, for measurement of any physical phenomena which may be resolved into a change of capacitance. Applications include micrometric and macrometric displacement, vibration measurement, dielectric measurement, pressure, thermal and humidity variation, etc. Analog conversion unit does not use a frequency stabilized oscillator, bridge, phase sensitive rectifier or discriminator. Transducer output is a phase sensitive



dc signal which may be as high as ±60v. Sensitivity as high as 5v. per mmf change in capacitance are developed. Only power supply and indicator are required. **Decker Aviation Corp.,** 1361 Frankford Ave., Philadelphia 25,
Circle No. **55** *on Reply Card*

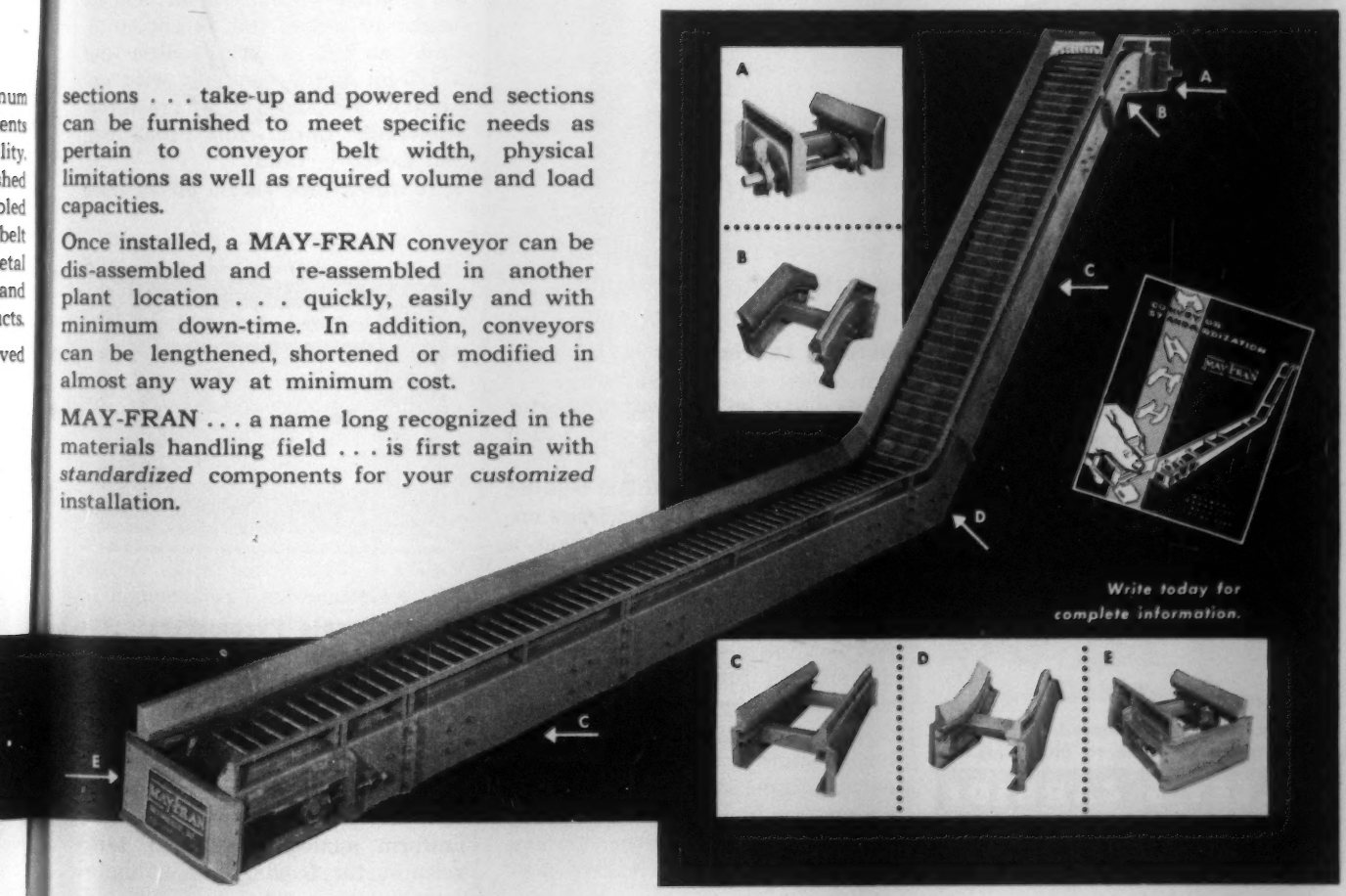
Pushbutton Switches

Designed for applications requiring on-off, single or double-pole, single throw controls, pushbutton switches are rated at 20 amp, 125v, and 10 amp, 250v, ac-dc. They are suited to a wide variety of electric appliance control applications. Red and black buttons give positive identification. Screw type terminals

sections . . . take-up and powered end sections can be furnished to meet specific needs as pertain to conveyor belt width, physical limitations as well as required volume and load capacities.

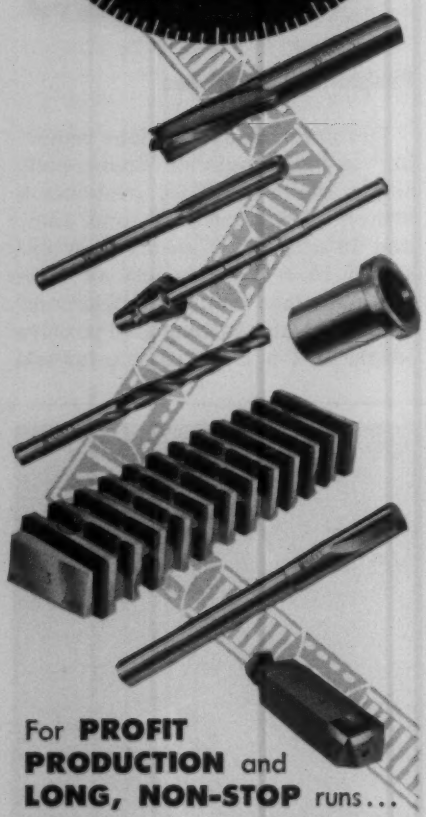
Once installed, a **MAY-FRAN** conveyor can be dis-assembled and re-assembled in another plant location . . . quickly, easily and with minimum down-time. In addition, conveyors can be lengthened, shortened or modified in almost any way at minimum cost.

MAY-FRAN . . . a name long recognized in the materials handling field . . . is first again with *standardized* components for your *customized* installation.



FOR THE BUSINESS END OF THE Automatics

WILLEY'S TUNGSTEN CARBIDE TOOLS



For **PROFIT PRODUCTION** and **LONG, NON-STOP** runs... Willey's Tungsten Carbide Tools best meet the demands of Modern Automation.

Write for catalogs:

Specialists in Preformed Carbide Shapes and Tools to Blueprints

WILLEY'S CARBIDE TOOL CO.

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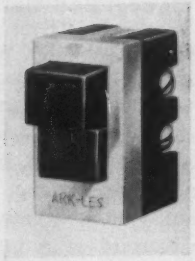


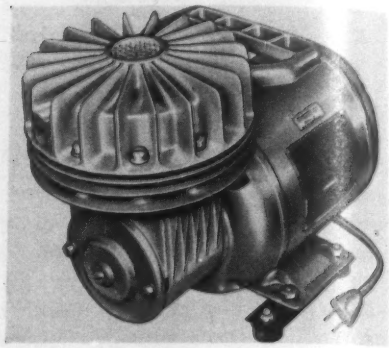
are recessed in side of molded phenolic body 15/16-inch wide, 1¾ inches long, with an overall depth including buttons of 1 15/16 inches. Switch can also be supplied as a single-button, momentary contact circuit control, single-pole single throw, or double pole single throw unit for normally closed or normally open circuits. **Ark-les Switch Corp.**, 51 Water St., Watertown 72, Mass.

Circle No. **56** *on Reply Card*

Bearing Lubricators

One-quart oil reservoir lubricator is available in ¼, ¾ and 1-inch pipe sizes with capacities to lubricate up to 32, 200 and 300 bearing inches respectively. Lubricators operate automatically and deliver a uniform rate of oil feed regardless of supply of oil in reservoir. Units permit a precisely controlled and uniform distribution of oil-fog to multiple lubrication points in simultaneous operation. Air-borne oil-fog maintains lower operating temperature of high speed rotating parts. Slight air pressure in bearing or gear housing prevents entry of dust, coolants or other foreign matter. Lubricators feature 360-degree visibility of oil feed in addition to visible oil supply. **C. A. Norgren Co.**, 3463 S. Elati, Englewood, Colo.

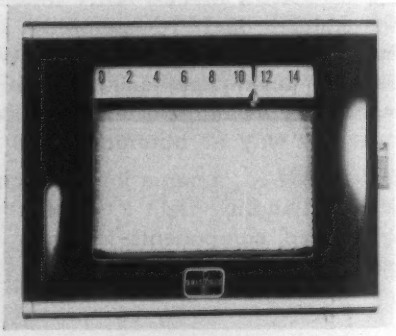
Circle No. **57** *on Reply Card*



Electric Air Compressor

Self-contained portable electric air compressor powers pneumatic devices where piped compressed air is not available. Compressor plugs in to any 110 or 220v ac line, delivers up to 100 psi pressure and 3.5 cfm free air. No tank or safety valve is required. Sealed ball bearings are used throughout compressor; no lubrication is needed. Overall length of unit is 13 inches, height 10 inches and weight 40 lb. Unit has built-in intake filter and a 1/3-hp motor equipped with capacitor and overload protector. **Modernair Corp.**, 400 Preda St., San Leandro, Calif.

Circle No. **58** *on Reply Card*

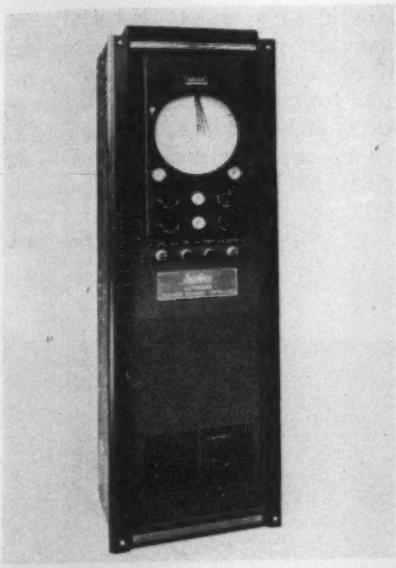


Thermocouple Pyrometers

New pyrometers are available with a linearizing cam which converts a nonlinear thermocouple millivolt signal into a straight line uniform form for recording and control. Device converts a non-uniform analog into linear form suitable for feeding into a digital

readout device. Conversion is achieved through the use of a cam and linkage in the slidewire housing in the potentiometer. This cam positions the slidewire contact, depending on the millivolt response curve of the thermocouple involved. With this mechanism, rotation of the contactor shaft is linear with thermocouple temperature. Record and indication are also linear, and a uniformly graduated chart is used. Unit can be used in processing problems requiring computer or servosystem control. **Bristol Co.**, Waterbury 20, Conn.

Circle No. **59** *on Reply Card*

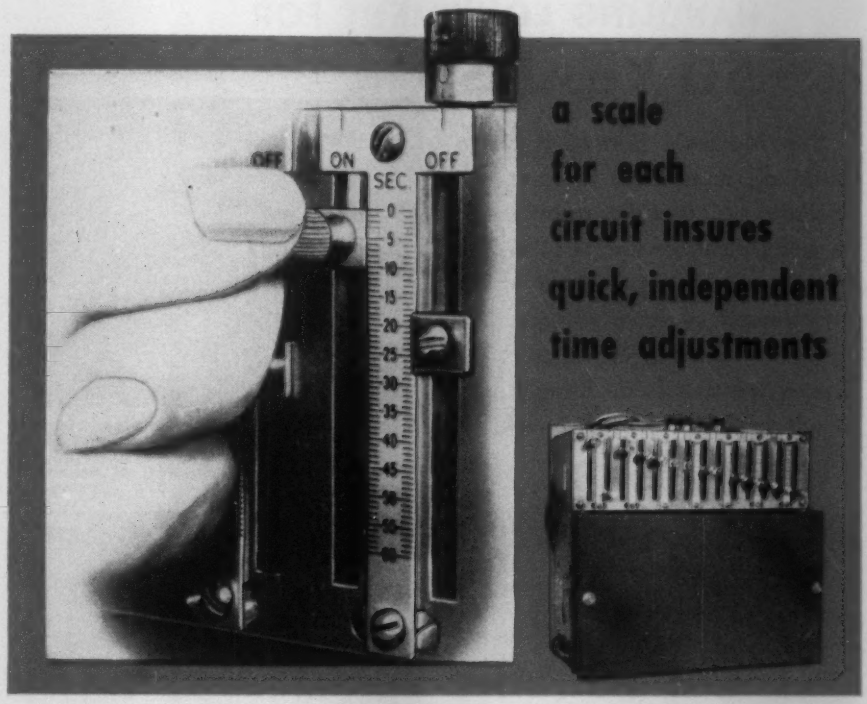


Pneumatic Recording Controller

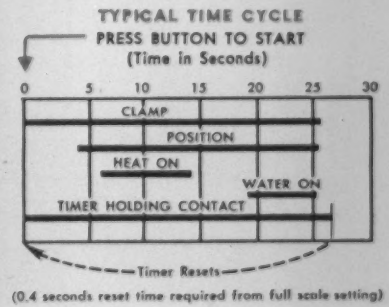
Designed to automatically control carbon potential in continuous or batch type controlled atmosphere heat treat furnaces, pneumatic recording unit can also be used to control the dewpoint of gas atmosphere generator. Controller uses "dewpoint method" of carbon potential determination. It incorporates features of company's electronic automatic recording controller, but is pneumatic type. Main feature of control system is ability to compensate automatically for any changes in work surface area as well as in gas analysis while the furnace is operating. Illustrated model is a dual record instrument, capable of simultaneously controlling two separate processes; single record models are also available. **Surface Combustion Corp.**, Toledo 1, O.

Circle No. **60** *on Reply Card*

EAGLE MULTIFLEX (multiple circuit) reset timer



For controlling operation phases of electrically energized devices in processing work. The Multiflex Reset Timer closes and opens one to six circuits during a time interval started by push button, limit switch or other means. It's the only multiple circuit timer that provides a calibrated scale for quick, independent adjustment of each circuit. Time changes are made rapidly by moving a simple slide adjustment. Settings are possible to 1% of full scale. Vernier knobs are provided for use where more accurate settings are required. Multiflex Timers are available with time scales from 30 seconds to 5 hours. Send for free bulletin.



(0.4 seconds reset time required from full scale setting)

EAGLE SIGNAL CORPORATION
Industrial Timers Division
MOLINE, ILLINOIS

Eagle timers save time . . . save money

MAIL COUPON TODAY

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Industrial Timers Division, Dept. A-955
MOLINE, ILLINOIS

Please send Bulletin 130 containing full data on Multiflex Reset Timer.

NAME AND TITLE

COMPANY

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